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THE DANISH
INGOLF-EXPEDITION.

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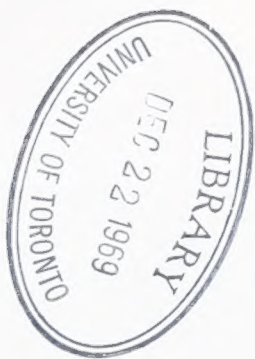


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THE DANISH INGOLF-EXPEDITION.

VOLUME V.

5.

STYLASTERIDAE.

BY

HJALMAR BROCH.

WITH 5 PLATES AND 6 FIGURES IN THE TEXT.



1965-41
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1914.

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Introduction.

The close examination of the Hydrocorallines meets perhaps with more difficulties than the study of the skeleton-bearing Hexacorallia, owing partly to the porous skeleton of the colonies, partly to the delicate nature of the organisms. The characteristics can be determined roughly by means of Dr. Koch's detailed method in which thin sections of the colonies are prepared by grinding with the stained soft parts in situ. The structure of the skeleton can also in part be studied by breaking the colonies as Hickson (1912 p. 891) seems from the following remark to have done. "The way in which it is possible to study the shape of the gasteropore styles is to make a vertical fracture in a plane parallel with the long axis of a branch. In a large percentage of such fractures the whole length of at least one gasteropore with its style will be exposed". It is evident however, that this method is not suited to form the base of a more thorough and systematic investigation of the skeletal parts of the colony. Where it is necessary for the observer to make his results free from chance irregularities he must have recourse to the somewhat slower method of grinding. In the present studies this latter method has throughout been used in the examination of the skeleton. The soft parts are first removed by means of Eau-de-Labarraque, and pieces of the colony have then been ground down on a fine and level whetstone as far as seemed necessary in each single case. For general systematic work it is usually sufficient to grind down a branch to about its median longitudinal plane; in a *Stylaster*, for example, the majority of the gasterostyles will in most cases appear quite free in the middle of the gasteropore. On the finely polished ground surface it will also be possible to study the course of the fine canals. Where there is question of examining the finer structure of the calcareous skeleton, however, this procedure is not sufficient and it is necessary in addition to have thin sections of the same kind as the geologists use in their studies.

Since Moseley's fundamental work on the Hydrocorallines appeared in 1881 investigators have mainly directed their attention towards unravelling the features of the skeleton of the colonies. Excluding a couple of smaller papers on the gonophores of a few species, no observer since that time has sought to penetrate deeper into the organisation and finer structure of the Hydrocorallines. The result is, that we cannot yet be said to have full knowledge of their affinities and thus of their systematic position, a matter I shall return to later. — On studying Moseley's work we see at once, that none of the species hitherto found in the northern seas have been closely investigated; as will be shown in the following; even their specific characters have been more or less imperfectly

studied. It was thus of the highest importance to examine the soft parts of the northern Hydrocorallines more thoroughly; as Pax correctly remarks in a recent work on stony corals (1910 p. 65), "wir dürfen uns nicht verhehlen, dass jede Art, von der nur das Skelett vorliegt, als unvollständig bekannt gelten muss, gleichgiltig, ob ihr anatomischer Bau für systematische Zwecke verwendbar ist oder nicht."

It appears from the investigations, that the least injurious solution with which to remove the calcareous constituents is that recommended by Pax (1910 p. 71): 100 parts 70 % alcohol, 10 parts concentrated nitric acid and 2 parts concentrated, aqueous phloroglucine solution. In small pieces of the colony the calcareous parts are usually completely removed during about 12 hours; larger pieces have sometimes to remain in the liquid up to 48 hours before all the carbonate of lime is removed. The coarser structure is then studied most easily by means of thick celloidin sections, the finer by means of thin paraffin sections. The staining methods depend in part on the fixation. In most cases I have obtained excellent pictures on staining with haematoxylin and counterstaining with eosine or picric-acid-fuchsine (van Giesson's). It is of interest to note, that the structureless organic tissue, which intersects the skeleton in all directions, is coloured very intensely by the eosine and acid-fuchsine in the same way as the supporting lamellae of the zooids, whilst the picric acid does not affect it in van Giesson's staining method. —

I cannot refrain from dwelling a moment here on the mineralogical composition of the skeleton. Pax has investigated the skeleton of *Flabellum inconstans* and found, that it consists of aragonite. He also brings together (1910 p. 70) the results of previous investigations in the same direction. According to his summary calcite has been determined as skeleton in *Corallium*, *Isis*, *Tubipora*, *Cystiphyllum* and *Anabacia*, whilst aragonite has been found in the following genera of Coelenterates: *Heliopora*, *Montipora*, *Echinopora*, *Distichopora*, *Madrepora*, *Stylopora*, *Pocilopora*, *Millepora*, *Sciatopora*, *Goniastrea*, *Podabacca*, *Galaxea*, *Fungia*, *Dendrophyllia*, *Porites*, *Astroides*, *Hydnophora*, *Sclerohelia*, *Coclaria*, *Pterogyra*, *Merulina*, *Favia*, *Stylaster* and *Trachypyllum*. — At my request the assistant at the Geological Institute of the Polytechnic High School in Trondhjem, Dr. C. W. Carstens, has examined the skeletons of our four northern Stylasterids. Examination by means of Meigen's reaction has shown, that the skeleton in all four is formed of aragonite.

We here face one of the great problems of biology. There can be no doubt, that the power of animals to produce aragonite in the one or the other manner must stand in connection with their power to make use of the magnesium of the sea-water; according to the investigations of mineralogists namely all aragonite contains magnesium. But what makes the matter so puzzling is, that alongside the animals which have aragonite skeletons live some others, which like *Corallium*, *Tubipora*, *Cystiphyllum* and *Anabacia* form calcite skeletons. This shows that it cannot depend on a mere chance whether the animal builds its skeleton of aragonite or calcite. It seems more than doubtful that the crystalline system should be of any importance here. Physical characters might probably be found in aragonite, which for most of the marine animals make it biologically more profitable than calcite. Unfortunately the differences between aragonite and calcite in physical regards are still so imperfectly known, that we are unable to form any reasonable supposition as to what part their occurrence plays in the biology of the marine animals.

The Stylasteridae of the North Atlantic.

Pliobothrus Pourtalès

The colonies are branched fan-shaped, often with dichotomously divided branches and branchlets. The gastropores and dactylopores open irregularly over the surface of the colony and are not collected into cyclic systems. The dactylopores open out on the top of lower or higher tubular projections. The gastropores are of varying depth, sometimes closed below by one or more tabulae; both the gastropores and dactylopores sometimes open without distinct ending into the large, irregular, central longitudinal canals of the colony. The gastropores and the dactylopores have no styles.

With this diagnosis the genus agrees fairly closely with the *Pliobothrus* of Moseley (1881 p. 94). There are a few changes however which require further mention. Moseley included as a generic character in his diagnosis the absence of tentacles in the gasterozoid, in spite of the fact, that his own investigations indicated that *Pliobothrus tubulatus* Pourtalès has 5—6 tentacles on the gasterozooids. When we remember the great variation to which the number of tentacles is subject in other genera, where they have been studied, this character is of extremely problematic value as generic character. The same applies to the form of the polyps, which more than anything else is dependent on the state of contraction and preservation. So long as we are unable to demonstrate more constant peculiarities in the form of the polyps than hitherto, it has no great value even as specific characteristic. The number of the gonophores in the ampullae must also be referred to the specific characteristics and may even here be of subordinate importance.

A close study of *Pliobothrus symmetricus* shows, that the pores of the zooids vary greatly in length and often stand in open communication with the large central canals which appear irregularly in the branches. This blots out the boundaries between *Pliobothrus* and the genus *Steganopora* recently described by Hickson and England (1905 p. 26). Open communications between the gastropores and the dactylopores may also exceptionally be found in *Pliobothrus symmetricus*. *Steganopora* must therefore be included under *Pliobothrus*. The species *Steganopora spinosa* Hickson and England, the only known species of this genus, stands very near to *Pliobothrus tubulatus* Pourtalès and will possibly on closer examination prove to be identical with the latter.

Pliobothrus symmetricus Pourtalès.

- 1871 *Pliobothrus symmetricus*, Pourtalès, Deep-Sea Corals p. 57, Plate IV, figs. 7 and 8.
 1874 — — — — —, P. M. Duncan, Madreporaria "Porcupine" p. 336, Plate 49, fig. 7.
 1879 — — — — —, Pourtalès, Corals "Blake" p. 211.
 1881 — — — — —, Moseley, Stylasteridae "Challenger" pp. 48, 80 and 84, Plate VIII, fig. 2.

The fan-shaped colonies are normally branched in one plane; sometimes a portion of the colony may develop to a new fan, which forms an angle with the primary plane. There is no distinct or prominent main stem. The gastropores are evenly distributed throughout the colony, somewhat more numerous on the front than on the back. The dactylopores, which open out on low, broadly conical

prominences, are mainly found on the front and lateral sides of the branches and are here irregularly arranged between the gasteropores. The gasteropores are sometimes provided with one or a few tabulae; both the gasteropores and dactylopores are sometimes in open communication with the irregular, large, central canals in the colony, exceptionally also with each other directly. The gasterozooids have no tentacles. The dactylozooids, which are attached by a narrow base in the pore, have a central lumen. — The ampullae are deeply placed. The male gonophores are composite and are developed singly in the ampullae. — The surface of the colony is smooth, not reticulate.

Colour (in alcohol): yellowish dirty gray.

Occurrence: at Florida and in the Northern Atlantic in depths of 190—700 m.

Material:

“Ingolf” St. 55 63°33' N., 15°02' W. depth 594 m. 5.9° C.

— - 57 63°35' - 13°02' - — 658 - 3.4° C.

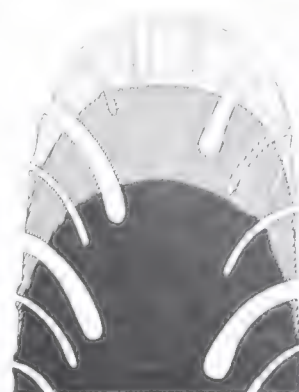
On the Ingolf Expedition some fragments and a complete colony of this peculiar species, which at first sight is all too readily regarded as a Bryozoon, were taken. The intact colony (Pl. I, figs. 1 and 2) shows the marked tendency of the species to branch dichotomously. This characteristic is also clearly seen in Pourtales' and Duncan's drawings. How far this is more than a specific character we are unable at present to determine with certainty, as only a few quite small fragments have been found of the other species of the genus *Pliobothrus*. Pourtalès' drawing of *Pliobothrus tubulatus* (1871, Pl. 4, fig. 9) suggests however, that we have here a specific character, the fragment figured at any rate is not branched dichotomously.

There is in general no very marked main stem in *Pliobothrus symmetricus*, nor do its branches show any regular difference in thickness. In this regard the intact colony of the “Ingolf” differs from those described earlier; the unbranched, basal part of the colony may best be described as a kind of main stem, although its dimensions do not in reality differ obviously from those of the branches. The other, somewhat smaller fragments are not so distinctly and simply fan-shaped. Single branches show a tendency to new fan formations in planes almost at right angles to the primary plane of the colony. As no other difference could be detected between the colonies, however, this must be considered as purely chance variations in the colonial form. — There is a sharply marked difference between the front and back of the colony. On the front the pores are evenly and densely distributed over the whole of the surface and here the dactylopores are present in large numbers; on the back, on the other hand, the dactylopores have practically disappeared and the number of gasteropores is also somewhat reduced. The difference becomes the more pronounced, the nearer we come to the base of the colony, the pores on the hind surface becoming more and more reduced both in number and size. In the above-mentioned, more irregularly branched fragments, all difference between the front and back disappears on the branches which emerge from the primary plane of the colony; the pores are evenly and densely distributed on the whole surface of these branches.

Under a low magnification already (Pl. I, fig. 3) we notice larger and smaller pores, which, however, are not arranged in rows or systems. The larger pores — gasteropores — have their opening plane at the level of the colony surface, whilst the small pores — dactylopores — are found on the top of small, conical protuberances. As mentioned above, the number of the dactylopores especially

is reduced on the hind surface of the colony; what may be the cause of this our imperfect knowledge of the biological conditions of the *Stylasteridae* does not enable us to explain.

If we grind down the branches to about the median longitudinal plane we are able to see the pores in the whole of their length (Pl. III, figs. 19 and 20) and it becomes apparent that these have a typical bend in their course, curving inwards towards the longitudinal axis of the branch and then downwards towards its base. The pores — especially the gastropores — are of varying length; the terminal pores are, as a rule, quite short and much shorter than those we find further in on the branches. This indicates a terminal and centrifugal growth in the branch and gives us the key to the understanding of the bent course of the pores (Text-fig. A). The pores are first formed at or near the tip of the branch and approximately in its longitudinal direction; during the growth of the branch the pore is gradually moved down on its cylindrical part. The plane of the opening of the pore lies at each place approximately at right angles to its longitudinal axis and the latter will therefore become curved during the growth of the branch, as will be seen from the accompanying diagram.



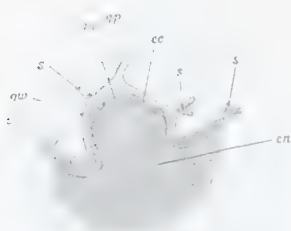
Text-fig. A. Diagram showing the arched development of the pores in *Pliobothrus symmetricus* during the growth of the colony.

A few of the gastropores open into large, irregular, longitudinal canals, which are formed secondarily in the central part of the branch; often however their base is formed of one or two tabulae. In their original form the gastropores are cylindrical with a slightly expanded basal part in which the zooid is attached; but during growth the gastropores often assume a more irregular appearance. The dactylopores also are of varying depth; they are cylindrical, more or less curved and have a slightly constricted opening region; the pore aperture itself, as mentioned, is situated on the top of a slightly prominent, almost wart-shaped protuberance. — The calcareous substance of the colony is penetrated longitudinally and transversely by fine canals in which the stolons lie. No regular arrangement could be noticed in these fine canals, neither in *Pliobothrus symmetricus* nor in our other North Atlantic Stylasteridae.

The connection of the pores and canal system in *Pliobothrus symmetricus* is of special interest, when we compare with the genus *Steganopora* established by Hickson and England (1905, p. 26). The open communication, which is not so very seldom observed between the pores and an irregular central canal system in *Pliobothrus*, is said by Hickson and England to be a constant and always occurring character in *Steganopora* and here also results in an open and direct communication between the gastropores and the dactylopores. Such a communication also occurs irregularly in *Pliobothrus symmetricus* and we cannot consider this as a fundamental difference between this species and *Steganopora spinosa*, as maintained by Hickson and England. In reality there is here only a gradual difference, which by no means entitles us to make a generic distinction and the last-mentioned species must therefore be referred to the genus *Pliobothrus*.

Moseley (1881) has shown, that the structure of the zooids in *Pliobothrus symmetricus* is very characteristic. The gasterozooid (Text-fig. B) has a fairly broad basal part, from the circumference of

which the stolons emerge. Examination of serial sections seems to suggest, that the endoderm in the basal part itself is strongly vacuolated; but this may also be due to the imperfect state of preservation. The protoplasm is here strongly granulated and all indicates, that the albumen cells (cf. Schneider 1902 p. 579) form the principal mass of the endoderm in the basal part of the polyp, whilst the



Text-fig. B. The contracted gastrozooid of *Pliobothrus symmetricus*. *ec* = ectoderm, *en* = endoderm, *m* = mouth, *s* = stolones, *gp* = the epithel of the gastro-pore, *gp* = mouth of the gastro-pore. (60/1).

nutriment cells are in majority in the endoderm of the free wall of the zooid. Apart from this localisation of the cell types the gastrozooid agrees in the whole of its structure with the Hydroid polyp, as is clearly shown by the figures (Text-fig. B, Pl. III, figs. 28 and 29). Whilst the large cnidocysts occur in fair numbers in the stolons, the small ones are concentrated in the walls of the zooids. In the gastrozooids (Pl. III, fig. 29) the cnidocysts are accumulated densely in the ectoderm near to the mouth of the polyp and entirely disappear further down on the polyp wall; in the dactylozooids they are more uniformly distributed in the ectoderm in the whole length of the zooid, but become however less numerous near its basis. — To judge from Moseley's drawing (1881 Pl. VIII, fig. 2) the gastrozooid should have a wide, cruciform mouth in *Pliobothrus symmetricus*. The mouth of the polyp is

closed in all the specimens examined from the "Ingolf" Expedition and is neither larger nor shaped differently from that of the Hydroids generally. The cruciform appearance noted by Moseley is clearly due to chance, for the protruding parts of the endoderm in the numerous sections examined vary greatly in form, size and number.

In their discussion of the family characters of the *Stylasteridae* Hickson and England state (1905 p. 13): "The solid scalariform endoderm of the dactylozooids is another very distinctive feature of the group". This does not hold good for *Pliobothrus symmetricus*; the dactylozooids have a distinct lumen in their centre, as shown in transverse sections (Pl. IV, fig. 34). The authors cited maintain, that "the scalariform tissue is clearly a much more differentiated tissue", — naturally, under the tacit assumption, that the dactylozooid is a reduced polyp. This would suggest, therefore, that Moseley's view of *Pliobothrus* as a primitive genus of the *Stylasteridae* is correct.

There is one condition, however, which seems to point in the opposite direction; this is the male gonophores and their structure. Moseley indicated already, that their appearance differs from that found elsewhere in the *Stylasteridae*. But his drawing (1881 Pl. VIII, fig. 3) is in so far misleading, as it gives the impression, that the difference only consists in a denser accumulation of very small, single gonophores. A series of sections through the male gonophores (Pl. IV, figs. 40—42) shows extremely aberrant features. Each ampulla contains a single, fairly large, globular gonophore, which is composed of a number of follicle-like portions (pseudofollicles); the reproductive cells are in extremely different stages of development in the various pseudofollicles of the gonophore. The spadix as a rule is slightly branched between the pseudofollicles and sometimes we find, that slender connecting bridges lead from the stolons of the ampullar wall over to other parts of the gonophore wall than those where its spadix connects with the stolons of the colony. — Hickson (1891) has demonstrated the formation of a "seminal duct" in *Stylasteridae* where the male gonophores are of primitive structure. Such a formation can certainly not be found in *Pliobothrus symmetricus*. The apex of the compound gono-

phore is prolonged (Pl. IV, fig. 42) but seems never to reach the surface of the colony. To judge from serial sections it opens out into one of the surrounding stolon canals of the calcareous skeleton at the side of and not in the stolon itself. The available material however is not sufficiently well-preserved to enable these conditions to be closely studied, nor does it give any clear picture of the structure or development of the opening of the gonophore.

It would be of great interest to clear up the origin and development of these compound gonophores. Probably we have here a secondary coalescence of the whole gonophore complex which we find collected into the single ampulla in most of the other *Stylasteridae*. The branched spadix and the varying stage of development of the reproductive cells in the single pseudofollicles point in this direction. Investigation of the *Stylaster* species shows, that the male gonophores in an ampulla are in very different stages of development and thus function over a long period; the successive maturation, which obviously must be of great importance for the species, is thus retained in *Pliobothrus symmetricus* after the gonophores have become fused into a single complex. Unfortunately the material has not permitted any close study of the development of the gonophore in the present species. — I was unable to find other developmental stages of the female gonophores than those already known from the work of Moseley. Thus nothing was found which differed from his description. —

Pliobothrus symmetricus was first described by Pourtalès (1871) from the Florida reefs, where it seems to be common between 180 and 300 m. in depth. The species has only once been met with in the Northern Atlantic, where P. M. Duncan (1874) mentions it from the cold area of the Faeroe Channel.

Stylaster Gray.

The usually fan-shaped colonies have the zooids collected into closed cyclosystems, which show no trace of opercula. Both the gasteropores and the dactylopores are provided with styles; the dactylostyles however may be rudimentary.

On the basis of this diagnosis we must also include the genus *Allopora* Ehrenberg in *Stylaster*. Hickson and England (1905 p. 6) rightly point out how small and doubtful the characters are, which are said to distinguish the two genera. In reality there are quite even transitions between the genera. None have shown this more clearly than Hickson and England, who following the proposal of Studer group the species into four divisions: "A. Cyclosystems on lateral sides of branches only; B. Cyclosystems on lateral sides of branches and a few on the surfaces; C. Cyclosystems evenly distributed over the surfaces of the branches, and D. Cyclosystems on the anterior surface of the branches only." The first two groups stand extremely near to each other and should be embraced within one main group or subgenus *Eustylaster*; the last group has just the arrangement of the cyclosystems which is characteristic of *Allopora*; species like *Stylaster divergens* Marenzeller and *Allopora rosacea* Greeff obviously occupy intermediate positions between our northern *Allopora* species with its hardly prominent cyclosystems and those *Stylaster* species which have very prominent, almost stalked cyclosystems. For group D. the old generic name *Allopora* should be retained.

The genus *Stylaster* is represented in the Northern Atlantic by three species, which have been confounded several times. When the ampullae are strongly developed the colonies in our *Eut-*

stylaster species may sometimes become so blown up and deformed that they may easily enough be confused with the *Allopora* species. To facilitate the determination in difficult cases I give in the following table their distinctive features.

	<i>gemmascens</i>	<i>rosens</i>	<i>norvegica</i>
Cyclosystems	with 12—20, normally 14—18 dactylo- pores. Wall of gasteropore deeply incised towards the dactylopores.	with 8—16, normally 9—11 dactylo- pores. Wall of gasteropore slightly incised towards the dactylopores.	with 5—9, normally 6—7 dactylo- pores. Wall of gasteropore slightly incised towards the dactylopores.
Gasterostyles	conical, twice as high as broad.	almost globular with same breadth as height.	almost globular with same breadth as height.
Ampullae (♀)	near the surface and projecting like a hemisphere; equipped with blunt spines.	near the surface and projecting like a hemisphere; without spines.	deeply embedded, scarcely seen externally on the colony.

Subgenus *Eustylaster* nov.

Stylaster gemmascens (Esper) Milne-Edwards et Haime.

1768 *Madrepora virginea*, Gunnerus, Om nogle norske Coraller p. 56, Tab. VIII, figs. 2—4.

nec 1758 *Madrepora virginea*, Linné, Systema naturae ed. X, vol. I, p. 798.

? 1797 *Madrepora gemmascens*, Esper, Fortsetzungen der Pflanzenthier, T. I, p. 60, Tab. 55.

1857 *Stylaster gemmascens*, Milne-Edwards, Histoire naturelle des Coralliaires p. 130¹⁾.

1873 — — , G. O. Sars, Dyrelivet paa vore Havbanker p. 45.

? 1874 — — , pars, P. M. Duncan, Madreporaria . . . "Porcupine" p. 332.

1879 — — , Storm, Bidrag til Kundskab om Trondhjemsfjordens Fauna p. 24.

1881 — — , Moseley, Stylasteridae "Challenger" p. 86.

1882 — — , Storm, Bidrag til Kundskab om Trondhjemsfjordens Fauna IV, p. 25.

1910 — — , J. A. Thomson, Note on a Hydrocoralline from Rockall p. 61.

1912 — — , Nordgaard, Faunistiske og biologiske iagttagelser p. 7.

1912 — — , Arndt, Zoologische Ergebnisse, I, p. 122.

The fan-shaped colonies have as a rule a concave front surface and show a distinct difference between stem, main branches and small branches. The cyclosystems are placed laterally and alternately on the outermost small branches and their main axis forms almost without exception a pointed angle of less than 45° with the axis of the branch; they are oval, except those just at the tip of the branch which may be circular, and show from 12 to 20, normally however 14—18 quite separate dactylopores, each provided with a rudimentary dactylostyle. The wall of the gasteropore shows deep incisions towards the dactylopores. The gasterostyle is conical, twice as high as broad. The gasterozoid has 4 quite small tentacles. — The female ampullae project like hemispheres above the surface of the colony and when fully developed are equipped with 1—7, generally 2—4 small, blunt spines. The surface of the colony is smooth and indistinctly reticulated.

Colour: white or faintly rose-red with darker yellowish red gasterozoids.

Occurrence: west coast of Norway, Denmark Strait in 50—560 m. depth, Rockall. (Indian Ocean?)

¹⁾ This work contains a detailed list of the older synonymy.

Material:

"Ingolf" St. 15	66°18' N. 25°59' W.	620 m.	÷ 0.75° C.
West coast of Norway	Hjeltefjord	ca. 150 m.	
	Gidskö (Söndmöre)	?	
	Söndmöre	?	
	Trondhjem Fjord	50—400 m.	6.5—8.5° C.

The form and appearance of the colonies are subject to such great variations in *Stylaster gemmascens*, that we may often be in doubt as to whether one and the same species is before us. The available material was very large, especially from the Trondhjem Fjord, where the species is fairly common and more luxuriantly developed than from any other locality hitherto known; further, I was able to examine a number of colonies from the west coast of Norway and lastly a couple of small fragments from "Ingolf" St. 15. Examination of this very large material shows the relationship of all the many different kinds of variants, partly owing to series of chain-forming variants, partly on account of apparently quite different growth-types being present in different branches of single colonies. Hickson in several of his works has divided up some of the species into a series of different "facies". As the most illustrating examples I may mention his treatment of *Stylaster eximius* Duchassaing et Michelotti (1905) and *Errina nova-zelandiac* Hickson (1912). The deeper meaning of these "facies" is not apparent from his method of treatment; they seem only to illustrate the varying growth modifications of the species; nor do we obtain any information as to the biological conditions under which they appear. In dealing with the present species, therefore, I discard the subdivision into "facies", which only serves to give the misleading impression that the species is divided into distinctly separated growth forms or types.

There is always a distinct difference present between the front and hind surfaces of the colony in *Stylaster gemmascens* and the more or less composite, fan-shaped colony is almost always bent somewhat inwards, so that the front surface becomes more or less concave. To give any explanation of the biological significance of these structural features cannot be done with certainty at present, least of all for our northern species, which only live in great depths. A conclusion by analogy from tropical species is excluded, since, as Hickson and England (1905 p. 4) point out, we lack all knowledge of the biology of these animals. — There is a gradual increase in thickness from the outermost small branches and inwards towards the thick main branches and main stem; the last are almost entirely free of cyclosystems. The small branches may sometimes show coalescences, but this is seldom.

On the outermost, fine branches we see how the cyclosystems arise alternately on the lateral sides of the branch; this is the primary condition in the species. The larger cyclosystems however are not restricted to the lateral part of the branch; they also extend far in over the front surface of this, as can be seen regularly a few millimetres inside the tip of the branch. The increase in thickness of the branch proceeds most rapidly on the hind surface; in this we may have one of the causes of the colony's tendency to bend in towards the front surface. It has the further effect, that the cyclosystems are secondarily moved more and more forwards towards the front of the branches, the nearer we come to their origin; at the same time a few irregularly situated, new cyclosystems arise between the old. Here and there we also find, that cyclosystems appear quite singly on the back of the colony but their number here is always very small.

When the material available only consists of some few fragments of *Stylaster gemmascens*, we may often be inclined to divide it up into several species, as already mentioned. Some pieces (Pl. I figs. 5—6) show a regular aspect with uniformly constructed branches; others on the other hand (Pl. I, figs. 4 and 7) are irregular in their mode of branching and in the arrangement of the cyclosystems. A larger material soon shows however, that there is no justification in creating subspecies on the basis of these variations. Often the appearance of the ampullae may alter the regular structure of the colony, though not quite so much as in the following species, with which it can easily be confounded. The most reliable mark of distinction between the two species is found in their cyclosystems and gasterostyles. But the female ampullae also afford good characters; in *Stylaster gemmascens* they are equipped with a varying number of conical, blunt spines; normally we find 3 or 4 of these on the ampulla, more seldom 2 or 1; often the number may also be larger and once 7 spines were found on a single ampulla. When the ampullae occur in larger number, these small spines appear in quantities between the cyclocystems and make the boundaries and arrangement of these indistinct to the naked eye (Pl. I fig. 7). Closer examination however shows that the cyclocystems are comparatively little affected by the ampullae.

The cyclosystems appear as small, oval, stellate elevations except at the very tip of the branches, where they are still circular in circumference. Even the tops of the septa-like separating walls between the dactylopores project somewhat strongly above the surface of the colony. The number of the dactylopores in the cyclosystems varies from 12 to 20; in general there are from 14 to 18 dactylopores round a gasteropore. The wall of the gasteropore shows a deep incision towards the dactylopore. Any fusion of the dactylopores which lie side by side could not be detected, as is often the case in some tropical species. — Carefully prepared longitudinal sections made by grinding readily show the gasterostyle (Pl. III fig. 21); in *Stylaster gemmascens* it is pointed, conical and almost twice as high as broad. A thin section (Pl. III fig. 24) shows clearly its lattice-work structure. The dactylostyles are reduced to faint, irregular elevations on the outer wall of the pores; they are very difficult to observe. — Thin sections of the stem and main branches show very distinctly, that the growth here as in our other northern *Stylaster* species proceeds centrifugally and periodically; but it still remains to discover, what influences in the sea produce this periodic growth in the colonies.

The gasterozoid has the same structure as the hydroid polyp, when we exclude the secondarily formed gasterostyle (Text-fig. C, Pl. III fig. 25). Partly near to and partly somewhat below the opening of the mouth we find four quite small, almost rudimentary tentacles. The small cnidocysts of the polyp are gathered in these tentacles, though without leading to the formation of a typical, thickened, distal part such as is found on the capitate tentacles of the *Corynidae*; their structure agrees fully with the thread-like tentacles we find in the athecate Hydroids. The ectoderm of the gasterozoid is normally destitute of stinging cells otherwise. The cell boundaries in the ectoderm are very difficult to make out; the whole structure here agrees with that of the Hydroids. Often we can observe outrunners which connect the ectoderm of the polyp wall with the epithelium of the gasteropore wall; these resemble the irregular outrunners, which are often found in the thecaphore Hydroids and which here connect the ectoderm of the hydranth with the hydrotheca outside the true, basal line of attach

ment. — The gastrozoid is provided with a strongly developed, supporting lamella. The endoderm cells are high and show the same cell types that are usually found in the lower Coelenterata; the endoderm continues on to the gasterostyle and forms its epithelial covering. Distinct cell boundaries can in general not be observed in the endoderm of the gasterostyle; the granulated structure shows, that the albumen cells are decidedly in majority here, whilst Schneider's "Nährzellen" (1902 p. 579) compose the main mass of the cells in the endoderm of the free gastrozoid wall.

A transverse section of the basal part of the gastrozoid gives an extremely characteristic picture (Pl. IV fig. 32). The tissues collect into separate columns which gradually become smaller in diameter and pass over into the stolons. No lumen could be detected in these columns until they change over into the typical stolons. Nor do they show any sign of differentiation into ectoderm and endoderm like the stolons. The number of columns does not seem to be constant.

The dactylozooids (Pl. IV fig. 33) have a very thick and muscular supporting lamella and show a more marked power of expansion and contraction than the gastrozoid. The thick ectoderm of the free wall of the dactylozoid is densely beset with cnidocysts, but the zooid is not capitate. The endoderm is scalariform and compact and thus the dactylozoid has no central lumen. The endoderm is on all sides surrounded by the supporting lamella and is not connected with the endoderm of the stolons. The nutrition of the dactylozoid from the stolons must therefore take place through its ectodermal wall. —

In spite of the very large material available for investigation I did not succeed in finding the male colonies and determine their number of gonophores in the ampullae. Nor were young stages of the female gonophores found in the numerous sections. The fully developed female gonophores (Pl. V figs. 46 and 49) have a complicated spadix. From a narrow base, where the main stolon enters into the ampullae, the spadix spreads out semispherically; it is formed by numerous, fine, endodermal blind sacs, the narrow and irregular lumens of which radiate out like the rays of a star from the centre of the base of the gonophore. As the single blind sacs as a rule have a twisted course and not seldom branch, the whole picture thus seems very complicated at first sight. The ripe ovum rests on the spadix like one hemisphere on another and the spherical gonophore, which occupies the ampulla, is surrounded by a thin endodermal layer. The colonies are not hermaphrodite and it is a puzzle even how fertilization takes place in these animals with their closed ampullae. — As the ovum gradually develops to a planula larva and grows in size, the spadix atrophies, its large cell material being probably used for the nourishment of the ovum. When the spadix is more reduced (Pl. V fig. 50) its structure becomes more distinct. — Other stolons of the wall of the ampulla may also secondarily come into connection with the gonophore and thus increase the amount of nourishment during the embryonal development.

It has long been an open question whether the larva ruptures the roof of the ampulla when it escapes. A series of sections through a number of large, empty ampullae points in an opposite direction; in spite of the fact, that the larva must just have escaped from the ampullae, their roof is



Text-fig. C. Diagrammatic median section through the cyclosystem of *Stylaster* (*Eustylaster*) *gemmascens*. The tentacles are not represented in this section. *d* = dactylozoid, *g* = free portion of the body-wall of the gastrozoid, *gs* = gasterostyle.

quite intact. It is probable indeed, that a fairly small opening is simply formed in the roof of the ampulla, through which the larva escapes. This opening is at once closed again and the ampulla persists for some time as a large empty space after the larva has escaped. The further fate of the ampulla has not been observed.

The synonymy of the species offers several difficulties. It is exceedingly doubtful, if it really was this species which Esper (1797 p. 60) described under the name of *Madrepora gemmascens* and the question cannot be settled from the literature. The reason for nevertheless retaining the specific name *gemmascens* here is, that our commonest northern *Stylaster*, wherever it is mentioned in the literature, appears under this name. Esper's specimens came from the Indian Ocean but no one has later found the species there. — The first quite certain and detailed description of the species is to be found in a treatise of Gunnerus (1768 p. 56), who erroneously identified it with Linne's *Madrepora virginica*; his drawings are the best which have ever been given of the species and the identification is all the more certain because his specimens are still preserved in the Zoological Museum of Trondhjem. One of them is reproduced in fig. 4 of Pl. I. Gunnerus examined several colonies of this species from the west coast of Norway, but his work has been passed over by later investigators and thus Esper has erroneously been taken as the first describer. We thus find, that Milne-Edwards (1857) was still unacquainted with the fact, that *Stylaster gemmascens* lives in northern waters. It was reserved for G. O. Sars (1872 p. 45) to point out its existence on the Norwegian coasts and he was the first to refer the northern colonies to Esper's species. In this he is followed by P. M. Duncan, who however in his work on the material of the "Porcupine" (1874 p. 332) confounds it with *Stylaster roseus* and *Stylaster (Allopora) norvegicus*; on the whole, to judge from his drawings it is extremely doubtful if Duncan has had any specimens at all of *Stylaster gemmascens*. Storm (1879 and 1881) found the species again in the Trondhjem Fjord and points out that it is fairly frequent in its occurrence there. Lastly, we find *Stylaster gemmascens* mentioned from Rockall; through the kindness of Prof. J. A. Thomson I have had the opportunity of examining his specimens, which are typical individuals of the northern species; it is the only certain instance of its occurrence south of the submarine ridge between Scotland—Iceland and Greenland. Excluding Esper's locality the species has not been found outside the North Atlantic and even there it lives within a fairly restricted area.

Stylaster roseus (Pallas) Gray

- 1766 *Madrepora rosca*, Pallas, *Elenchus Zoophytorum* p. 312.
 1857 *Stylaster roseus*, Milne-Edwards, *Histoire Naturelle des Coralliaires* T. II, p. 130¹.
 1871 — *crubescens*, Pourtalès, *Deep-Sea Corals* p. 34, Pl. IV figs. 10 and 11.
 ?1871 — *roseus*, Pourtalès, l. c. p. 83.
 1874 — *gemmascens* pars, P. M. Duncan, *Madreporaria* . . . "Porcupine" p. 332, Pl. 49, figs. 13—15.
 1877 — *roseus*, Lindström, *Contributions to the Actinology of the Atlantic Ocean* p. 15.
 1878 — *crubescens*, Pourtalès, *Corals* . . . "Blake" p. 210.
 1881 — *roseus* + *S. crubescens*, Moseley, *Stylasteridae*, "Challenger" pp. 86 and 87.

¹) This work contains a detailed list of the older synonymy.

The fan-shaped colonies are in general branched in one plane and not recurved; they display a marked difference between small branches, main branches and stem. The cyclosystems are placed laterally and alternately on the small branches; their main axis forms an angle of 45° or more with the longitudinal axis of the branch. The cyclosystems are circular except on the thick main branches, where they have a more oval form. The cyclosystem shows from 8 to 17, in general 9–11 quite separate dactylopores, each provided with an almost rudimentary dactylostyle. The wall of the gasteropore has quite a small incision towards the dactylopores. The gasterostyle is almost spherical with the same height as breadth. The gasterozoid has four very small tentacles. — The male ampullae generally contain 4 to 6 gonophores and are scarcely seen on the surface of the colony. The female ampullae appear like hemispheres on the surface of the colony; they are smooth, without spines. The surface of the colony is smooth and faintly reticulate.

Colour: rose with lighter stem and main branches.

Occurrence: Atlantic Ocean in depths from 230 to 1400 m.

Material:

"Ingolf" St. 7	63°13' N., 15°41' W.	1128 m.	45° C.
— - 15	66°18' - 25°59' -	620 -	—0.75° -
— - 17	62°49' - 26°55' -	1400 -	3.4° -
- - 52	63°57' - 13°32' -	789 -	7.87° -
— - 94	64°56' - 36°19' -	204 -	4.1° -
"Thor" 1904	65°50' - 26°53' -	392 -	?
East Greenland Expedition.	Off Angmagsalik	263 -	?

At first glance *Stylaster roseus* is confusingly like the preceding species; it may especially be easily confounded with such colonies of the latter as are represented in figs. 5 and 6 of Pl. I. Closer examination however shows that there are great and constant differences between the colonies, so that they must be taken as representatives of different species. The first mark of distinction apparent on comparing larger colonies is the form of colony itself. In *Stylaster roseus* there is a greater difference between the main branches and the small branchlets than in the preceding species and the colony is more robust; in addition, the branching of the colony in *Stylaster roseus* normally proceeds in a single plane and it seldom shows a slight tendency to curve inwards towards the front surface. When the colonies are in full process of reproduction they are often so swollen also in the outermost small branches (Pl. II, fig. 11) that there is danger of confusing the species with *Stylaster (Allopora) norvegica*. The position of the cyclosystems in relation to each other on the outermost small branches however shows that the species here dealt with belongs to the subgenus *Eustylaster*. The main axis of a cyclosystem is at right angles to the axes in the inner-lying and the succeeding cyclosystems and this is more obvious than in *Stylaster gemmascens*, where the cyclosystems owing to the smaller angle with the branch axis do not give the small branches such a distinct zigzag form as in *Stylaster roseus*. In addition the number of the dactylopores is on the whole less in *Stylaster roseus*, their number varying between 8 and 17 but in general lying about 9 to 11. Further, the communication of the dactylopores with the central gasteropore takes place through a smaller incision in the gasteropore wall than in *Stylaster gemmascens*.

The most decisive and constant characters however are found in the condition of the gastero-styles and ampullae. Whilst the gasterostyle in the preceding species was conical and twice as high as broad, in *Stylaster roseus* it is almost transformed to a spherical lattice-work (Pl. III, fig. 22), which rests with a broad base on the bottom of the gasteropore. In fertile colonies the female gonophores especially project like hemispheres above the surface of the colony; whilst the female gonophores in the preceding species were equipped with spines, in the present species they are quite smooth. These are important differences, which compel us to consider the colonies as representing quite different species.

Examination of the structure of the tissues in *Stylaster roseus* reveals such small and unessential differences from *Stylaster gemmascens*, that we can only ascribe them to the bad preservation of the specimens of the present species. It is only represented in the material by dried fragments and colonies, which have been placed directly in 70% alcohol. The only difference which might possibly prove to have some importance is, that the large stinging cells, which are extremely seldom in *Stylaster gemmascens* and *Stylaster (Allopora) norvegicus*, are fairly numerous in the stolons of *Stylaster roseus*; they are not found here either in the zooids.

Most of the colonies are fertile. There is nothing to indicate that they are hermaphrodite and the largest specimens, which come from the waters off Angmagalik (Greenland), are male. The condition of preservation of the material did not permit any exhaustive examination of the gonophores. I shall therefore only refer here to some few features, which have some interest when compared with the few and scattered observations hitherto reported regarding the gonophores of the *Stylasteridae*. — On young developmental stages of the male gonophores (Pl. IV fig. 36) we see, that the gonophore has a well-developed central spadix, which however does not reach the apex of the gonophore. No trace could be found of an endodermal cell layer under the ectoderm, which according to Hickson (1891 p. 392) surrounds the spermarium of the gonophore in the *Stylasteridae*. Nor did I succeed in finding indications of such a cell layer in the later developmental stages. — When the sexual cells approach maturity we still find a distinct spadix (Pl. IV fig. 39) which extends into the spermarium towards the centre of the gonophore. During the transformation of the spermatocytes to spermatozoa the spadix atrophies and disappears in gonophores with fully developed spermatozoa.

During the last transformation we should expect to find the development of the seminal duct, which according to Hickson is characteristic of the *Stylasteridae*. Fig. 43 of Pl. V shows the condition in *Stylaster roseus* at a spot where the seminal duct should be expected; the picture is of a gonophore with the spermatozoa almost fully formed. A slight thickening of the ectodermal epithelium can be detected both in the gonophore and on the adjacent part of the roof of the ampulla; but a comparison with other gonophores indicates that this is merely a chance. Even at this place, where the spermatozoa would very soon escape, we find no trace of the formation of a seminal duct. The apex of the gonophore points towards a neighbouring stolon canal and at other places also the conditions suggest, that the gonophores of the ampulla empty their ripe sex cells into adjoining stolon canals and not directly out through the roof of the ampulla. The conditions seen cannot be explained by the state of preservation, for they are the same in all the cases, where the course of the cell layers can be determined with certainty.

The female gonophore in its fundamental features is constructed as in *Stylaster gemmascens*. But its spadix is simpler in structure (Pl. V figs. 47 and 48); it is bowl-shaped. Whilst the spadix in *Stylaster gemmascens* develops blind sacs in the direction towards the central parts of the gonophore, all the blind sacs in *Stylaster roseus* lie along the periphery of the gonophore. The structure may here be said to be more primitive than in *Stylaster gemmascens*.

The synonymy of the species is not easily determined with certainty from the literature. No differences between the available colonies and the old descriptions of *Stylaster roseus* can be found. As the species is the commonest Stylasterid in the Atlantic north of the equator, it is probably the same form that served as a basis for Pallas' description of *Madrepora rosca*; the name also agrees with the colour as noted by the collectors of the present material. The only disagreement to be noticed between these colonies and Milne-Edwards' description (1857 p. 130) is, that the small branches seldom show coalescences; but this character is of little importance and can scarcely be considered sufficient as a specific distinction. Pourtalès (1871 p. 34) under the name of *Stylaster crubescens* describes a species from the deeper layers at Florida; his excellent figures show at once, that it cannot be specifically distinct from the North Atlantic *Stylaster roseus*; on the other hand, it is exceedingly doubtful if it is this species which he (l. c. p. 83) with doubt refers to Pallas' species as *Stylaster roseus*. P. M. Duncan (1874 Pl. 49 figs. 13—15) figures the species from the Faeroe Channel, but refers it erroneously to *Stylaster gemmascens*. *Stylaster roseus* is common in the northern Atlantic south of the submarine ridge between Scotland—Iceland and Greenland.

Subgenus *Allopora* (Ehrenberg)

Stylaster norvegicus (Gunnerus)

- 1768 *Millepora norvegica*, Gunnerus, Om nogle norske Coraller p. 64, Tab. II figs. 20—22.
 1873 *Allopora norvegica*, G. O. Sars, Dyrelivet paa vore Havbanker p. 45.
 1874 *Stylaster gemmascens* pars, P. M. Duncan, Madreporaria . . . "Porcupine" p. 332, Pl. 49 figs. 1—3.
 1881 *Allopora oculina*, Moseley, Stylasteridae, "Challenger" p. 85.
 1882 — *norvegica*, Storm, Bidrag til Kundskab om Trondhjemsfjordens Fauna, IV, p. 26.
 1888 — *oculina* + *A. norvegica*, Hickson, On the maturation of the ovum and Development of *Allopora* p. 595.

The fan-shaped colonies are generally branched in one plane; they are not recurved and show no distinct division into stem and branches. The cyclosystems are arranged irregularly; they are most numerous on the front surface of the colony. They are circular or more rarely somewhat oval and have from 5 to 9, in general 6—7 quite separate dactylopores, each with a faintly developed dactylostyle. By means of a shallow incision the gasteropore stands in communication with the dactylopore. The gasterostyle is approximately spherical, of the same height as breadth. The gasterozoid has from 5 to 7, in most cases 6 quite small tentacles. — The ampullae are deeply imbedded and are hardly seen on the surface of the colony. The male ampullae contain in general 3, seldom 2 or 4 gonophores. The surface of the colony is smooth, not reticulated.

Colour: white or faintly rose with strongly yellowish red gasterozooids.

Occurrence: North Atlantic and west coast of Norway at depths from 100 to 1400 m.

Material:

"Ingolf" St. 15	66°18' N., 25°59' W.	620 m.	—0.75° C.
— - 17	62°49' - 26°55' -	1400 -	3.4° -
— - 52	63°57' - 13°32' -	790 -	7.87° -
— - 55	63°33' - 15°02' -	594 -	5.9° -
"Thor" 1904	65°50' - 26°53' -	392 -	?
	Hardanger Fjord	?	?
(G. O. Sars leg. 1871)	Storeggen (at Aalesund)	?	?
	Trondhjem Fjord	100—400 -	6.5—7.5° C.

Stylaster norvegicus is of coarser make than the preceding species (Pl. II figs. 12—15) and shows no distinct main stem. Even the outermost tips of the branches may often be very thick (Pl. II fig. 15) and the cyclosystems show no regular arrangement as in our *Eustylaster* species. Nevertheless superficial observation may easily confuse the species with colonies of the preceding species which are deformed by the numerous ampullae (cf. Pl. II, fig. 11). — The branches in *Stylaster norvegicus* are often flattened in the transverse plane of the colony. There is a marked difference between the front and back, the number of cyclosystems being very greatly reduced on the back of the colony (Pl. II figs. 13 and 14).

The cyclosystems are very regular in their formation in *Stylaster norvegicus*. They are almost circular and surrounded by a slightly raised ridge, which continues out into the septa between the dactylopores. As the ampullae are very deeply immersed, their development causes no disturbance of the regular form of the cyclosystems. In general there are 6 or 7, more rarely 8 quite separate dactylopores round the open and deep gastropore. The wall of the gastropore shows an incision not specially deep towards the dactylopore. — The short and broad gasterostyle is very characteristic; it is approximately spherical and has almost the same breadth as height (Pl. II fig. 23). The dactylostyles are a little more prominent than in the two previous species, but they are also rather difficult to observe in *Stylaster norvegicus*.

The ampullae are deeply imbedded in the branches and in general cannot be seen externally on the colony; but branches with ampullae are on the whole thicker than sterile branches. — The growth of the colony proceeds after the same type as in the *Stylaster* species already dealt with; the concentric layers, which indicate a periodic growth in the colony, are also distinct here on thin transverse sections of branches of the colony and are also readily seen in transverse series of sections of branches which are freed from their calcareous substance.

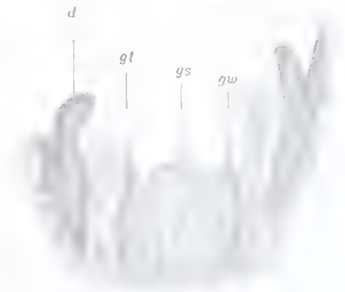
Whilst in the two preceding species we constantly find four tentacles on the gasterozooids the number varies in *Stylaster norvegicus*. As a rule the gasterozooid has 6 quite small tentacles, but sometimes their number is reduced to 5 or increased to 7. The tentacles (Text-fig. D, Pl. III figs. 27 and 31) are also very small here; we might be inclined to call them rudimentary. They are also here the seat of the small cnidocysts, which the gasterozooid is on the whole provided with. There is no reason

whatever here or anywhere else to call the tentacles capitate; they are formed quite like the thread-like tentacles in the athecate hydroids. — Further, the gastrozoid shows in its finer structure no difference from what has been described in *Stylaster* (*Eustylaster*) *gemmascens*. In the present species it is also broken up at the base into a circle of columns, the number of which seems mostly to be about 6. — The structure of the dactylozoid also agrees with that in the other northern species of *Stylaster*; but the dactylozooids are somewhat larger in *Stylaster norvegicus* than in the previous species. The large cnidocysts are found in extremely small numbers in the stolons.

Whilst the preceding species was only represented by specimens not very well-preserved, the opportunity was taken to obtain fresh material of *Stylaster norvegicus* from the Trondhjem Fjord, in the outer part of which the species is fairly common in suitable localities. Both male and female colonies could be examined and even if most of the questions concerning the development of the gonophores must still remain unanswered, yet the investigation contributes a good deal to the understanding of the nature of the gonophore in *Stylaster*.

The sexual cells are already present in the youngest developmental stage of the male gonophore which was found (Pl. IV fig. 35) so that their origin cannot be settled. The gonophore shows clearly, that Hickson (1891 p. 384) was wrong in maintaining, that "the spermarium is covered by a double sheath of very thin ectoderm and endoderm". Neither at this stage or later can anything be seen in the numerous gonophores examined (Pl. IV, fig. 37), which could be taken for an endodermal layer between the ectoderm and the generative cells. — Hickson (l. c. p. 390) maintains as a typical difference between the gonophores in *Allopora* and *Distichopora* that the latter genus has no spadix, whilst *Allopora* has a strongly developed spadix. In *Stylaster* (*Allopora*) *norvegicus* the spadix is strongly developed in the young gonophores but atrophies during the transformation of the sperm cells (Pl. IV fig. 38) and lastly disappears entirely in the mature gonophore as is the case also in *Stylaster roscus*.

The present species forms in part the basis for Hickson's studies on the seminal duct. Unfortunately I did not succeed in finding all the developmental stages of it and it is remarkable that it is not always to be found in almost or quite ripe gonophores in spite of the fact, that the preservation of the material is excellent. It seems doubtful, if under all conditions it comes to development even in all gonophores within the same colony; its importance therefore must be reduced in the general considerations on the group. — The youngest developmental stage found (Pl. V fig. 44) appears as a collection of somewhat higher and lighter-coloured cells at the apex of the gonophore. The rudiment is distinctly double, for under the thickened ectoderm cells there is a collection of inner cells (I), which have a characteristic, almost fibrillar protoplasmic structure; these fairly large and light-coloured cells are separated from the outer ectodermal layer by a very fine lamella. At a more advanced stage, when the seminal duct is almost fully formed (Pl. V fig. 45) the inner cells push the thin lamella in front of them into a conical point, which is surrounded by the more deformed ectodermal cells. The



Text-fig. D. Diagrammatic median section through the cyclo-system of *Stylaster* (*Allopora*) *norvegicus*. *d* = dactylozoid, *gt* = tentacle of the gastrozoid, *gs* = gasterostyle, *gw* = free part of the body-wall of the gastrozoid.

fibrillar protoplasmic structure of the inner cells is still more marked at this late stage than before and is most distinctly seen in the distal part of the developing organ. — I did not succeed in finding a fully formed seminal duct.

We have now the question: from which cell layer arise the inner cells of the duct, are they ectodermal or endodermal? The question cannot be answered on the basis of the present investigations. If Hickson's view were correct, that the spermarium of the gonophore is surrounded by a thin endoderm layer, their origin from the endoderm would be a consequence. But the investigations give no support to this view and it is contradicted by Hickson's own figure (1891 Pl. 30 fig. 15) of the young gonophore in *Distichopora*. The endodermal layer round the spermarium might be a later formation, but this theory does not find any support either in the present investigation. Provisionally therefore the question of the origin of the inner cells in the seminal duct must remain unanswered.

The female gonophores agree down to the smallest detail with those of *Stylaster gemmascens*. The mature egg is surrounded by an ectodermal layer and in *Stylaster norvegicus* no indication can be found either of an endodermal layer between the egg-cell and the ectoderm, as Hickson (1891 p. 390) has found to be the case in *Distichopora*. During the development of the egg the spadix atrophies and the pictures obtained of the condition in *Stylaster gemmascens* (Pl. V figs. 46, 29 and 50) are fully illustrative of the conditions in *Stylaster norvegicus*. Here also I did not succeed in finding the young developmental stages of the female gonophore.

The first description of the species is found in a paper of Gunnerus (1768 p. 64), who calls it *Millepora norvegica*. In an appendix (l. c. p. 67) he states that the species is identical with *Millepora aspera* which Linné described somewhat later in the 11th edition of the *Systema naturae*. The original specimens of Gunnerus are preserved in the Zoological Museum of Trondhjem; one of them is represented in fig. 12 Pl. II. — It is doubtful if it really is the same species which is described by Ehrenberg under the name of *Allopora oculina*. In Milne-Edwards' diagnosis of the latter species (1857 p. 132) we find: »Coenenchyme très-developpé, couvert de points très-serrés, visible seulement avec des verres grossissants«. This does not agree with the quite smooth surface, which is characteristic of *Stylaster (Allopora) norvegicus*. On the other hand, the specimens which are sometimes referred to in the literature from the Norwegian west coast under the name of *Allopora oculina* are undoubtedly identical with *Stylaster norvegicus*, the only *Allopora* met with in the northern Atlantic. It is this species which formed the basis of G. O. Sars' classical investigations (1873 p. 45), in which he restores the specific name of Gunnerus but refers it to the genus *Allopora*; he is of opinion that the species is identical with Ehrenberg's *Allopora oculina*. G. O. Sars was the first to describe the conditions in a living Stylasterid, after studying colonies of *Stylaster norvegicus* out on Storeggen on the west coast of Norway. He was in doubt as to the coralline nature of the animal, as he never succeeded in observing the extended polyps, when the colonies were at rest in sea-water, as is the case in our northern corals otherwise, and when he later studied the preserved animal somewhat more closely he expressed his opinion (l. c. p. 46): »though I am far from considering this¹⁾ as completed, yet I have already learnt this much, that the animal is essentially different from the other corals and probably does not belong at all to the *Anthozoa* but rather to the *Hydrozoa*«. As is well-known, Moseley a year later (1878)

¹⁾ i. e. the investigation.

confirmed the correctness of Sars' supposition. — Since Storm (1882 p. 169) some years later mentioned the occurrence of the species in the Trondhjem Fjord, we find little or nothing in the literature regarding its occurrence on the west coast of Norway.

The species has been figured however by P. M. Duncan (1874 Pl. 49 figs. 1—3) from material from the »Porcupine«; the identity of the colony from the figures given cannot be doubted, though the author refers it erroneously to *Stylaster gemmascens*. Moseley (1881 p. 85) notes the species under the name of *Allopora oculina*; Hickson (1888 p. 594) mentions the species from the Hardanger Fjord as *Allopora oculina* and from the »Triton« Expedition as *Allopora norvegica*. Apart from the doubt whether the two species belong together, the present species must in any case under the international rules of nomenclature retain the specific name which was given it already by G. C. O. Sars in the year 1768.

Remarks on the affinities and systematic position of the Hydrocorallines.

After L. Agassiz in 1859 had pointed out the Hydroid nature of the *Millepora* and Moseley in 1878 had indicated, that the organisation of the Stylasterids also characterised them as *Hydrozoa*, no one has doubted that the Hydrocorallines are most nearly related to the Hydroids and in reality must be regarded as highly specialised Hydroids, whose main characters are the power of the colony to form a skeleton of calcium carbonate and the polymorphic development of their polyps. These are thus the main characters which mark off Moseley's order *Hydrocorallinae*.

Closer consideration of these characters entitles us to doubt, however, whether on such a basis we are justified in raising the Hydrocorallines to the rank of a special order. If we compare them for example with the large order of corals, we see how the greater or less ability of the colonies to separate out carbonate of lime — as for example in the *Umbellula* species — is only regarded as a specific character and is not even sufficient for a generic separation of the species, unless the lime-excreting function is combined with distinct morphological changes in the individuals or colonies. It is thus a question, whether the latter is the case or not when we compare the Hydrocorallines with the Hydroids. We must therefore in the first place endeavour to ascertain, to which of the Hydroids the Hydrocorallines are most closely related.

The first hint is obtained from the tectonic structure of the colony itself. The fine anastomosing canals of the decalcified Hydrocoralline are quite homologous with the stolons of the Hydroid colony; we thus remark a conspicuous resemblance between the *Stylasteridae* and the *Hydroceratinidae*¹⁾. Even the structure of the colony agrees exactly in *Clathrozoön Wilsoni* Spencer and the primitive *Stylasteridae*, only the chitin of the skeleton being replaced in the *Stylasteridae* by a thick layer of calcium carbonate. Another Hydroid group also, *Solanderiinae* (family of *Corynidae*, cf. Kühn 1913) shows the same structure of the colony and can be imagined as standing near the parent stem of the Hydrocorallines.

The structure of the polyp will perhaps show the further line of connection. Most Hydroid investigators lay great stress systematically on the form of the tentacles and consider them one of the principal phylogenetic characters. Moseley (1881 p. 46) maintains, that the tentacles of the Hydro-

¹⁾ By Kühn (1913 p. 228) the *Hydroceratinidae* are considered a subfamily of *Bougainvilliidae*.

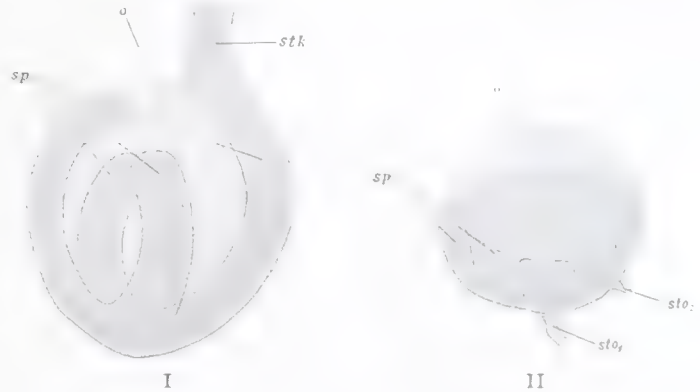
corallines, where they occur, are capitate or rather »knobbed at their tips«. Closer comparison of his drawings and of the figures later authors have given indicates, however, that the *Stylasteridae* do not have capitate tentacles like the *Corynidae*, even though the cnidocysts are accumulated more densely in the distal part of the tentacles. It has been pointed out several times in the foregoing, that the tentacles in the northern *Stylasteridae* fully agree in their structure with the thread-shaped tentacles of the *Bougainvilliidae*. On the other hand, the *Milleporidae* have typical, capitate Corynid tentacles. This suggests that the Hydrocorallines have a diphyletic origin and that the excretion of a calcareous skeleton in the two groups is purely a character of convergence. This witnesses further to the correctness of the separation of the Hydrocorallines into two families, as is done by Hickson and England (1905 p. 1.). On the other hand, we are not entitled to regard the two groups as sub-orders; we should rather consider them as two highly specialised Hydroid families. Hickson and England take the *Milleporidae* as Hydroids, whilst they regard the *Stylasteridae* as most nearly related to the *Trachomedusae*; what support they may have for this last view, does not appear anywhere in their works; the consequence is, that Hickson in his contribution to »The Cambridge Natural History« (1906) discusses the two families at widely separated places. — The structure of the gastrozooid in the Stylasterid genera as in *Sporadopora* and still more *Errina* agrees fully with the polyp of the *Bougainvilliidae*; excluding the gasterostyle, which phylogenetically must be of fairly recent origin and which does not occur either in all Stylasterids, the gastrozooids of the *Stylasteridae* fully agree with the polyps of *Clathrozoön*. This indicates, that the latter genus contains the nearest allies of the *Stylasteridae* among the Hydroids.

The second main character, the polymorphic development of the polyps in the *Stylasteridae*, we find already indicated in such *Bougainvilliidae* as *Hydractinia*; in several species of these we find tentacle-less »feelers« and tentacle-bearing nutritive individuals. In the *Hydractinia* species this distinction is not considered a useful mark of generic separation, nor can it be considered so important a feature in the *Stylasteridae*, that it can form the basis for a separation of the group into a special order, even if the dimorphic development of the somatic individuals has become a constant character.

We have hitherto directed attention exclusively to the somatic individuals, assuming that they give the most important supports in judging of the phylogenetic conditions of the Coelenterates. — Hickson (1891) through his evidence of a medusa generation in *Millepora* has produced the last incontrovertible proof of the Hydroid nature of this genus; the medusa seems to be an undoubted *Anthomedusa* and thus shows clearly the close relationship with the *Corynidae*. On the other hand the *Stylasteridae* have sessile gonophores. Moseley (1881 p. 93) maintains that the gonophores of the *Stylasteridae* are »adelocodonic«; but he regards the spadix of the female gonophores as an organ (the trophodisc) special to the *Stylasteridae*. Hickson later (1888 and 1891) has examined the gonophores more closely and supports Moseley's view, that the trophodisc is a special formation in the *Stylasteridae* which is no direct parallel to the spadix of the hydroid gonophores.

If we consider the manifold nature of the development and organisation shown by the gonophores of the Hydroids, the special character of the trophodisc and gonophores of the *Stylasteridae* becomes extremely doubtful. In his excellent studies on the hydroid gonophores (1910) Kühn has shown, that the medusa reduction may be so complete, that even the endocodon may disappear; thus

only the manubrium remains as spadix. In his figures (1888 Pl. 38 figs. 4 and 6) Hickson has shown cases of such reduced gonophores in *Distichopora* and the northern *Stylaster* species also have similar gonophores. Even though such a gonophore structure has not yet been shown in the *Bougainvilliidae*, yet it is not without a parallel in the athecate Hydroids. In *Eudendrium racemosum* (Cavolini) the spadix is bifurcated into two or often three branches, which claw-like embrace the egg-cell (Text fig. E). This is in fact a simplified trophodisc; an increase in the number of the spadix branchings would very soon lead to the condition we have found in *Stylaster roseus* and the step from this to the condition in *Stylaster gemmascens* and *Stylaster norvegicus* is also short. There is thus no fundamental difference present, which justifies the raising of the *Stylasteridae* to a special order.



Text-fig. I: Female Gonophore of *Eudendrium racemosum* (Cavolini) from the Adriatic. II. Semidiagrammatic figure of the female gonophore of *Stylaster roseus* (Cavolini) from the Adriatic. *stk* = stalk of the gonophore, *sto*₁ = main stolon of the gonophore, *sto*₂ = secondary stolon of the gonophore, *sp* = blind sacs of the spadix.

There is one condition however to which Hickson ascribes even greater weight. In his work on the gonophores in *Distichopora* and *Allopora* he states (1891 p. 392): »Comparing the adelocodonic gonophores (fig. 4) with the male gonophores of *Allopora* (fig. 5), two points of difference may be observed. In the first place the endoderm completely surrounds the gonad in the latter, excepting at a small aperture at the distal pole, where it forms the inner wall of a seminal duct. Secondly, there is no layer of ectoderm between this endoderm and the gonad of *Distichopora*. In the adelocodonic gonophore there are two layers of ectoderm between the gonad and the wall of the gonangium».

Quite apart from the disagreements between Hickson's results and the present studies on the gonophore structure in the *Stylasteridae*, his argumentation is hardly maintainable in the light of later studies on the gonophores of the Hydroids. In a species such as *Coryne fruticosa* Kühn (1910 p. 65, Taf. 6 figs. 25—27) has shown, that the gonophores have just the structure which Hickson gives as characteristic of *Distichopora* and *Allopora*. It is thus not without a parallel in the Hydroids. Much more rare then is the still simpler gonophore type in the Hydroids, where the endodermal cell-layer has also disappeared; nor is this without a parallel however; according to Kühn (1912 p. 199) it has been found in *Gymnogonos crassicornis* and in *Eudendrium simplex*.

The only gonophore type in the *Stylasteridae*, which in reality differs greatly from the known conditions in the Hydroids, is the male gonophore in *Pliobothrus symmetricus*. With its follicular structure this shows a higher stage in the gonophore structure than any other gonophore we as yet know from the lower Coelenterata. In reality we have here striking evidence of the fact, that the gonophore structure has been greatly overestimated in judging of the phylogeny of the Hydrozoa; one of the most primitively organised Stylasterids has the most highly organised gonophore type of all.

¹⁾ After specimens from Triest kindly sent me by Hr. Dr. C. Lehnhofer (Innsbruck).

In its structure *Pliobothrus* shows several features which indicate, that it stands nearer to the origin of the *Stylasteridae* than most of the other Stylasterid genera. In the first place, the zooids are not yet collected into distinct cyclosystems but are irregularly scattered over the colony; no regularity in the occurrence of the gastrozooids and dactylozooids can be detected. In the second place, the dactylozooids are less reduced than in the other *Stylasteridae*, as they still retain their inner cavity; nor do they show the marked division between an expanded basal part attached to the skeleton and a distal tentacle-like part, which is inserted obliquely on the basal part, as in most of the other *Stylasteridae*. Lastly, the gastrozooids lack a gasterostyle. These features show, when taken together, that *Pliobothrus* occupies a primitive position. *Pliobothrus* shows further, that the conservative, somatic parts of the colony are less exposed to the influence of the surroundings, to adaptive tendencies, than the generative parts, the power of which to change plastically in relation to the special biological demands is of vital importance for the existence of the species. In this therefore we also see the reason for the great variety displayed by the hydroid gonophores and in this we have the reason, why the gonophores of nearly allied species may be quite different. Owing to their conservatism in development the polyps are of the most important phylogenetic interest. The gonophores, the generative individuals, on the other hand, might almost be said to be a play-ball in the hands of chance biological conditions and thus phylogenetically have much less interest; they are suited to display the subdivision of the genera into biological adaptive groups and are thus more exposed to the influence of convergence than the other parts of the colonies.

We must therefore not ascribe too great importance to the condition of the gonophores in judging of the affinities of the *Stylasteridae* in relation to the other Coelenterata. Their organisation according to the results of all investigations may well be compared with that of the Hydroid gonophores and even if a single genus shows somewhat special features, they can by no means be used as evidence for the view, that the *Stylasteridae* are more distantly related to the Hydroids than the *Milleporidae*.

Bringing together the main points of the above discussion the result is, that we in reality cannot consider the Hydrocorallines as anything else but two convergent Hydroid families, which are characterised by their power to develop a skeleton of calcium carbonate and by the dimorphic development of their somatic individuals. The family *Milleporidae* traces its origin to that of the *Corynidae*, whilst the *Stylasteridae* is a highly specialised branch which has been derived from the *Bougainvilliidae*. Just as the *Corynidae* are distinguished from the *Bougainvilliidae* by their capitate tentacles, the *Milleporidae* with their capitate tentacles are distinct from the *Stylasteridae*, in which the tentacles are constructed like the thread-shaped tentacle type of the *Bougainvilliidae*.

Zoogeographical remarks on the North Atlantic Stylasteridae.

Few animal groups have been so little investigated in our northern waters as the Hydrocorallines. They do not form any prominent faunistic element, it is true, as they are only represented by four species in the northern Atlantic and of these, as known, only two penetrate into the Norwegian Sea. But by contrast these two species at several places form a very characteristic element in the large biocoenosis of the *Lophohelia* reefs and form here a complete and extremely interesting parallel to the numerous Stylasterid species of the tropical coral reefs.

A very speaking example of how little attention has been paid to the Atlantic Stylasteridae on reference being made to the faunistic conditions of this ocean is found in a statement in Parker and Haswell's Textbook of Zoology (1897 p. 147): »The Hydrocorallinae occur only in the tropical portions of the Pacific and Indian Oceans, where they are found on the »coral reefs: partly or entirely surrounding many of the islands in those seas«. Nevertheless, some of the oldest, quite identifiable descriptions of *Stylasteridae* are those given by Gunnerus in his work »Om nogle norske Coraller« (1768). His figures leave no doubt as to the identity of the species and his originals, which all came from the west coast of Norway, are preserved in the Zoological Museum of Trondhjem. — The work of Gunnerus has been little known owing to the humble and little distributed journal in which the paper was published. But several papers have also been published later in which the Atlantic *Stylasteridae* are mentioned and here we must place in the first rank Pourtalès' excellent work on the deep-sea corals (1871), in which he describes quite a number of Stylasterids from the American side of the Atlantic, especially from the waters round Florida. Pourtalès described here for the first time *Pliobothrus symmetricus* and also mentions a second of the North Atlantic species, *Stylaster roscus*, under the name of *Stylaster erubescens*. In addition, we have still two other, old records from the North Atlantic. G. O. Sars (1871) has given a classic description of the living *Allopora norvegica* and P. M. Duncan (1874) mentions Stylasterids from the Faeroe Channel. With exception of the work of Gunnerus all these papers are cited in detail by Moseley (1881) in his great work on the *Stylasteridae* of the »Challenger«.

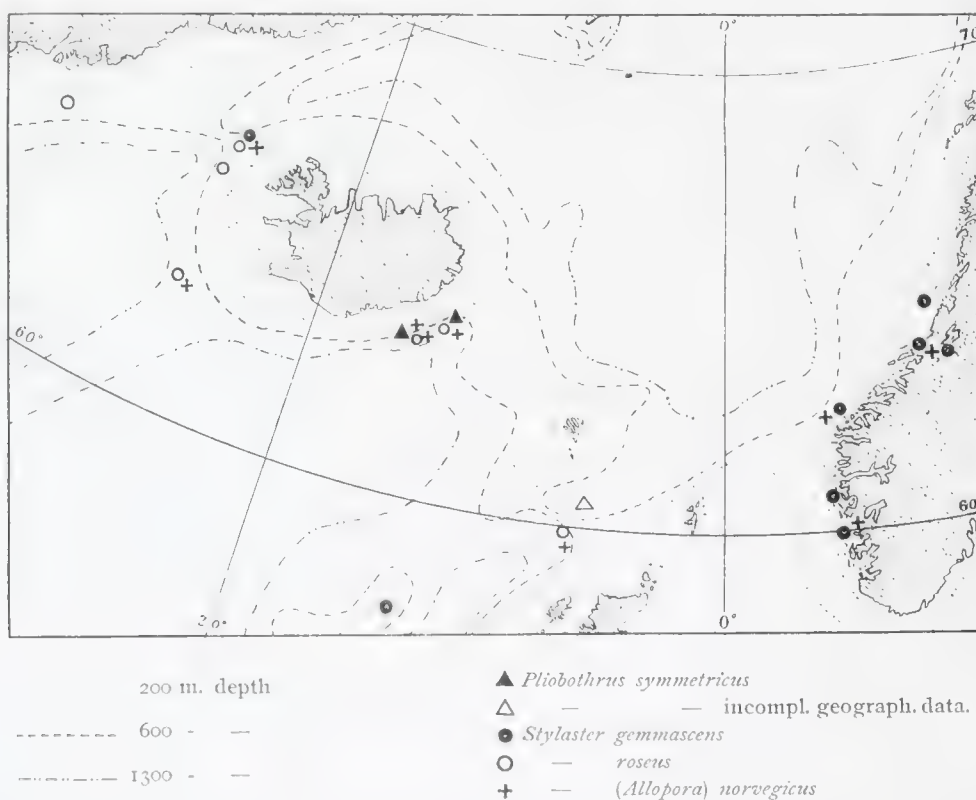
Later information regarding the northern Stylasterids is very meagre. Storm (1882) mentions *Stylaster gemmascens* and *Allopora norvegica* from the Trondhjem Fjord; there is a casual remark by Hickson (1891), that he has had material of *Allopora oculina* from the Hardanger Fjord and of *Allopora norvegica* from the »Triton« Expedition; lastly, J. A. Thomson (1910) informs us, that he has examined colonies of *Stylaster* from Rockall.

On the basis of the literature, therefore, we cannot penetrate very far into the biogeographical conditions of the northern Stylasterids. In this respect the comparatively large material collected by the »Ingolf«, »Thor« and the East Greenland Expedition of 1900 fills up a large gap in our knowledge. Supplementing this material with that preserved in the museums of Christiania and Trondhjem and further with observations from the Trondhjem Fjord we are able to throw a fairly good light on the biogeographical conditions of this enigmatical group in our northern waters.

As already noted, the *Stylasteridae* in the Norwegian Sea are typical coral reef dwellers. Yet at places in the Trondhjem Fjord *Stylaster gemmascens* is able to live in somewhat shallower water, sometimes even in towards a depth of 50 metres. This must depend on the special biophysical conditions of the fjord and it is of interest to note in this connection, that according to the investigations the species is only able to live in the shallower parts at places where projecting, submarine cliffs or barriers force the masses of water upwards which are brought in by the tidal wave. The shallowest occurrence of the species lies near its innermost boundary in the fjord. In the outer parts of the fjord, on the other hand, where the sides of the fjord are steeper and more regular, the species as also *Stylaster (Allopora) norvegicus* is bound to the *Lophohelia* reefs and both species here as elsewhere

must be regarded as characteristic forms of the large biocoenosis of the coral reefs. This is also strengthened by the single discovery of *Stylaster gemmascens* made in the Hjelte Fjord in the neighbourhood of Bergen, where Dr. O. Nordgaard has obtained two small fragments of colonies from the coral reef there.

We thus see that the two *Stylaster* species which occur on the coast of Norway, form interesting parallels in the animal community of the northern coral reefs to the Stylasterids of the tropical coral reefs. They are thus, like the *Lophohelia* reefs as a whole, bound in their occurrence to those localities with hard bottom, where the Atlantic current makes its influence most felt in the Norwegian Sea.



Text-fig. F. Map showing the localities of the Stylasteridae in the North Atlantic and the Norwegian Sea.

The study of the occurrence of the North Atlantic Stylasterids shows several biogeographical features of interest (cf. Chart Text-fig. F). — *Pliobothrus symmetricus* was first described from the waters round about Florida and must be fairly common there between 190 and 300 metres. It has been found by the »Ingolf« on the steep slope off the south coast of Iceland towards the depths of the Atlantic in 594 and 658 metres. According to Duncan (1874 p. 336) the »Porcupine« obtained a single specimen in the cold area of the Faeroe Channel; unfortunately he does not state the exact locality. We thus have a species here which belongs to the warm Atlantic waters and normally is not able to penetrate in over the submarine ridge, which towards the south separates the Norwegian Sea from the depths of the Atlantic. The one find in the cold area must be a pure chance and forms a parallel to the single and scattered finds which have been made here and there in the Norwegian Sea of other typical warm water forms among the Hydroids.

Stylaster roseus forms a parallel to *Pliobothrus symmetricus*. It is fairly common between 230 and 620 metres at Florida and on the whole has probably a greater bathymetric distribution than *Pliobothrus symmetricus*. *Stylaster roseus* is much more frequent in its occurrence than the latter form, but is restricted in the Atlantic to the south of the submarine ridges and has not yet been found in the Norwegian Sea. The »Ingolf« has taken the species at a single place in the Denmark Strait in water of negative temperature; this occurrence is due probably to a submarine wave making the conditions inhabitable for the species when it became attached as larva or that the station at the time of observation was covered by a wave of the cold polar water — In the Norwegian Sea the species is replaced by the nearly allied *Stylaster gemmascens*, which in reality must be ranged with the extremely few animals, which are entirely bound to the warmer layers of the Norwegian Sea. We may feel tempted to consider it a biologically defined, local species, which has divided off from *Stylaster roseus*. The two species have only been found side by side with certainty at the above-mentioned boundary station in the Denmark Strait, where the line of separation must be drawn between the Atlantic deep-water region and the boreal water-layers. This is the only time that *Stylaster gemmascens* has also been found in water of negative temperature. Once the species has been identified with certainty south of the Wyville-Thomson ridge, a couples of colonies being found at Rockall; the fauna at Rockall however has a strong mixture of species, whose chief occurrence is bound to the Norwegian Sea.

Finally, the last species *Stylaster norvegicus* is an Atlantic species which belongs to the North Atlantic and has been able to penetrate into the Norwegian Sea, where it has found a new home in the warmer water-layers there. Its occurrence shows a secondary centre in the Trondhjem Fjord, where along with *Stylaster gemmascens* it is more abundant than anywhere else in the northern parts of the Atlantic. The occurrence of the species in more southern waters cannot be accepted as certain, for its systematic characters have hitherto been too little unravelled; but it can hardly be very common there.

Trondhjem, November 1913.

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EXPLANATION OF THE PLATES

The following letters indicate the same parts in all Plates.

Ae Ectodermal epithelium of the ampulla.	Gp Gasteropore.
Cn Cnidocysts.	Gs Gasterostyle.
Dp Dactylopore.	I The inner cells of the seminal duct.
Ds Dactylostyle.	O egg cell.
Ec Ectoderm.	Sp Spadix.
En Endoderm.	s Stolon.
e Ectodermal epithelium of the gastero- pore wall.	T Tentacle.
Ge Ectoderm of the gonophore.	t tabula.
	W Free wall of the gasterozoid.

Plate I.

Plate I.

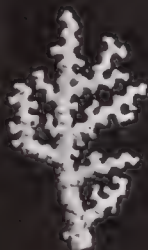
- Fig. 1. *Pliobothrus symmetricus*; front surface of an intact colony from the "Ingolf" St. 55. Natural size.
- 2. — — hind surface of the same colony. Nat. size.
- 3. — — two ends of branches from "Ingolf" St. 55. $\frac{4}{1}$.
- 4. *Stylaster gemmascens*; one of the type specimens of Gunnerus' *Madrepora virginica* from the west coast of Norway. Nat. size.
- 5. *Stylaster gemmascens*; front surface of an openly built colony from the Trondhjem Fjord. Nat. size.
- 6. *Stylaster gemmascens*; hind surface of same colony. Nat. size.
- 7. — — front surface of the compact branch of a fertile colony (♀) from the Trondhjem Fjord. Nat. size.
- 8. *Stylaster roscus*; front surface of a fragment of a colony from Angmagsalik with male ampullae Nat. size.
- 9. *Stylaster roscus*; hind surface of the same fragment. Nat. size.



Plate II.

Plate II.

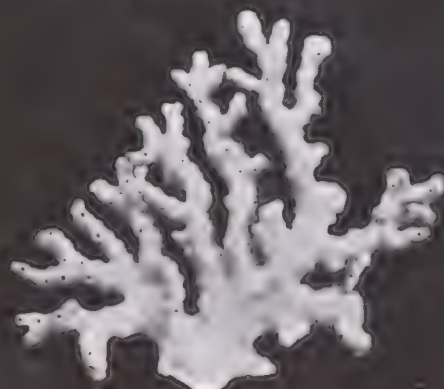
- Fig. 10. *Stylaster roseus*; front surface of a fragment of a colony with female ampullae; "Ingolf" St. 15. Nat. size.
11. *Stylaster roseus*; fragment of a colony which is entirely deformed owing to the development of numerous female ampullae; "Ingolf" St. 7. Nat. size.
- 12. *Stylaster norvegicus*; one of the type specimens of Gunnerus' *Millepora norvegica* from west coast of Norway. Nat. size.
- 13. *Stylaster norvegicus*; front surface of a narrow-branched colony from Trondhjem Fjord. Nat. size.
- 14. — — hind surface of the same colony. Nat. size.
- 15. — — front surface of a broad-branched colony from Trondhjem Fjord. Nat. size.
- 16. — *gemmascens*; ends of two branches of a colony from Trondhjem Fjord. $\frac{4}{1}$.
17. — *roseus*; end of a branch of a colony from "Ingolf" St. 15. $\frac{4}{1}$.
- 18. — *norvegicus*; ends of two branches of a colony from Trondhjem Fjord. $\frac{4}{1}$.



10.



13.



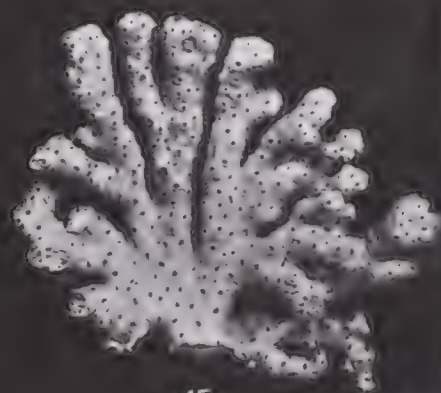
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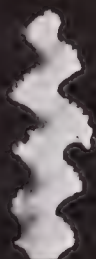
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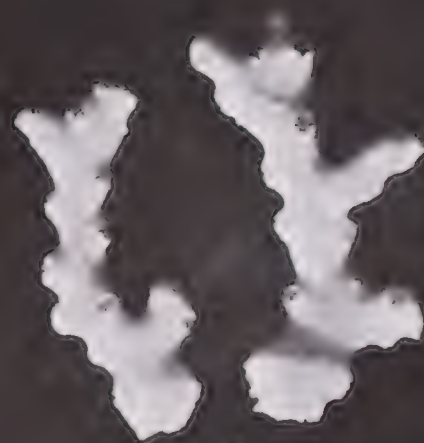
15.



17.



16.



18.

Plate III.

Plate III.

- Fig. 19. *Pliobothrus symmetricus*; median longitudinal section of a branch point. $16/\mu$.
— 20. — — — median section through a gasteropore with tabula. $16/\mu$.
-- 21. *Stylaster gemmascens*; median longitudinal section of a branch. $16/\mu$.
22. — *rosicus*; median longitudinal section of a branch. $16/\mu$.
— 23. — *norvegicus*; longitudinal section through two cyclozooids. $16/\mu$.
24. Median, longitudinal, thin section of the gasterostyle in *Stylaster gemmascens*. $90/\mu$.
25. Longitudinal section of the gastrozooid in *Stylaster gemmascens*. $130/\mu$.
-- 26. Transverse section of the gastrozooid at the base of the tentacles in *Stylaster gemmascens*. $300/\mu$.
27. Oblique transverse section of the gastrozooid at the base of the tentacles in *Stylaster norvegicus*. $300/\mu$.
28. Transverse section of the gastrozooid in *Pliobothrus symmetricus*. $300/\mu$.
29. Longitudinal section through the oral part of the gastrozooid wall in *Pliobothrus symmetricus*. $450/\mu$.
30. Longitudinal section through the oral part of the gastrozooid wall and tentacle in *Stylaster gemmascens*. $450/\mu$.
31. Longitudinal section through oral part of the gastrozooid wall and tentacle in *Stylaster norvegicus*. $450/\mu$.

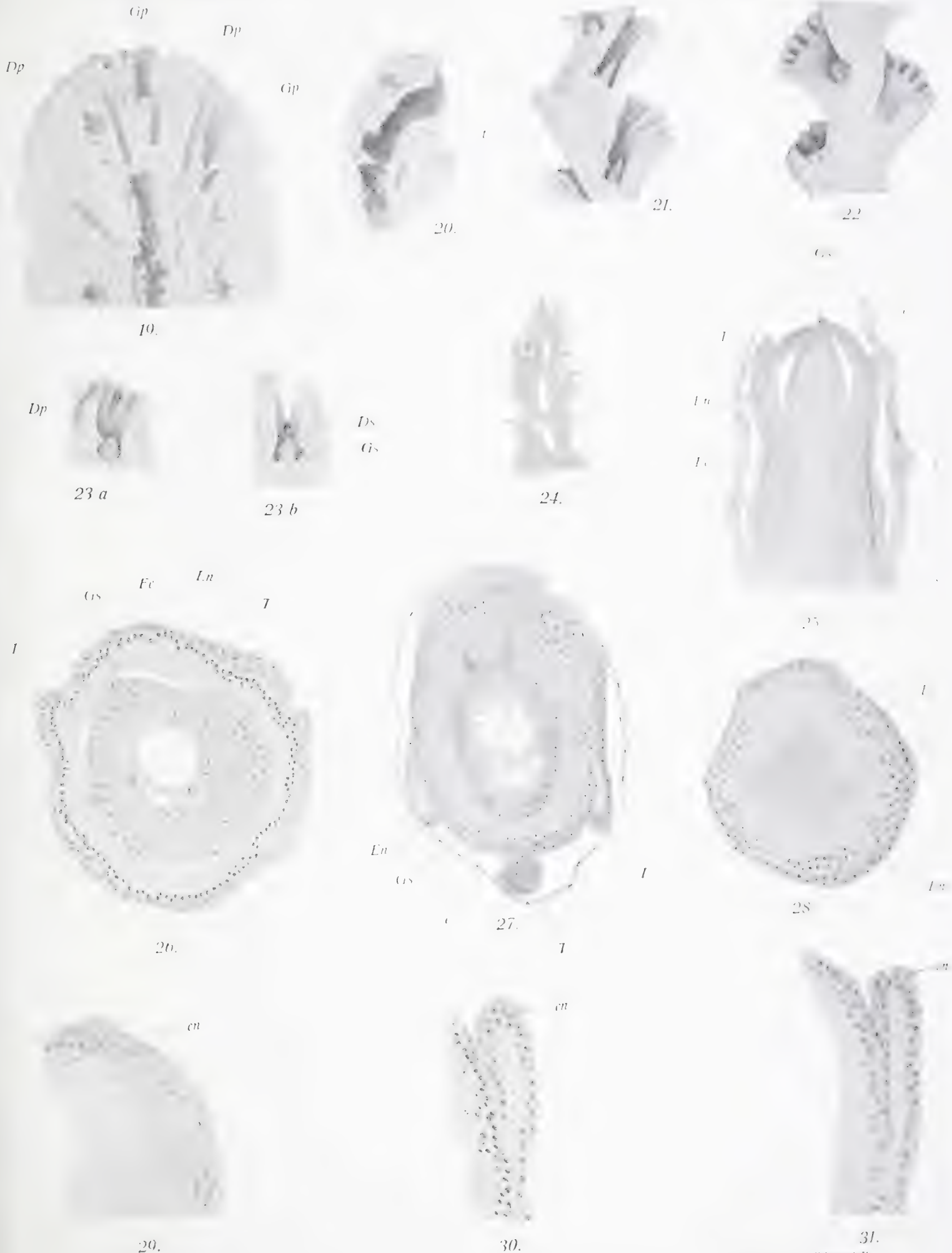


Plate IV.

Plate IV.

- Fig. 32. Transverse section of the gastrozoid at its base near its transition into the stolons in *Stylaster gemmascens*. $300\times$.
- 33. Longitudinal section of the dactylozoid in *Stylaster gemmascens*. $300\times$.
 - 34. Transverse section of a dactylozoid in *Pliobothrus symmetricus*. $300\times$.
 - 35. Median longitudinal section of a very young gonophore (♂) in *Stylaster norvegicus*. $450\times$.
 - 36. Median longitudinal section of a young gonophore (♂) in *Stylaster roseus*. $450\times$.
 - 37. Median longitudinal section of an unripe gonophore (♂) in *Stylaster norvegicus*. $300\times$.
 - 38. Median longitudinal section of two gonophores (♂) in *Stylaster norvegicus*. The larger with spadix partially atrophied contains spermatocytes in process of transformation to spermatozoa. $130\times$.
 - 39. Median longitudinal section of a gonophore (♂) in *Stylaster roseus*; the spermatocytes in process of transformation to spermatozoa. $130\times$.
 - 40. Transverse section of a young gonophore (♂) in *Pliobothrus symmetricus*. $300\times$.
 - 41. Median longitudinal section of a gonophore (♂) in *Pliobothrus symmetricus*. $300\times$.
 - 42. Median longitudinal section through apex of the fully developed gonophore in (♂) *Pliobothrus symmetricus*. $300\times$.

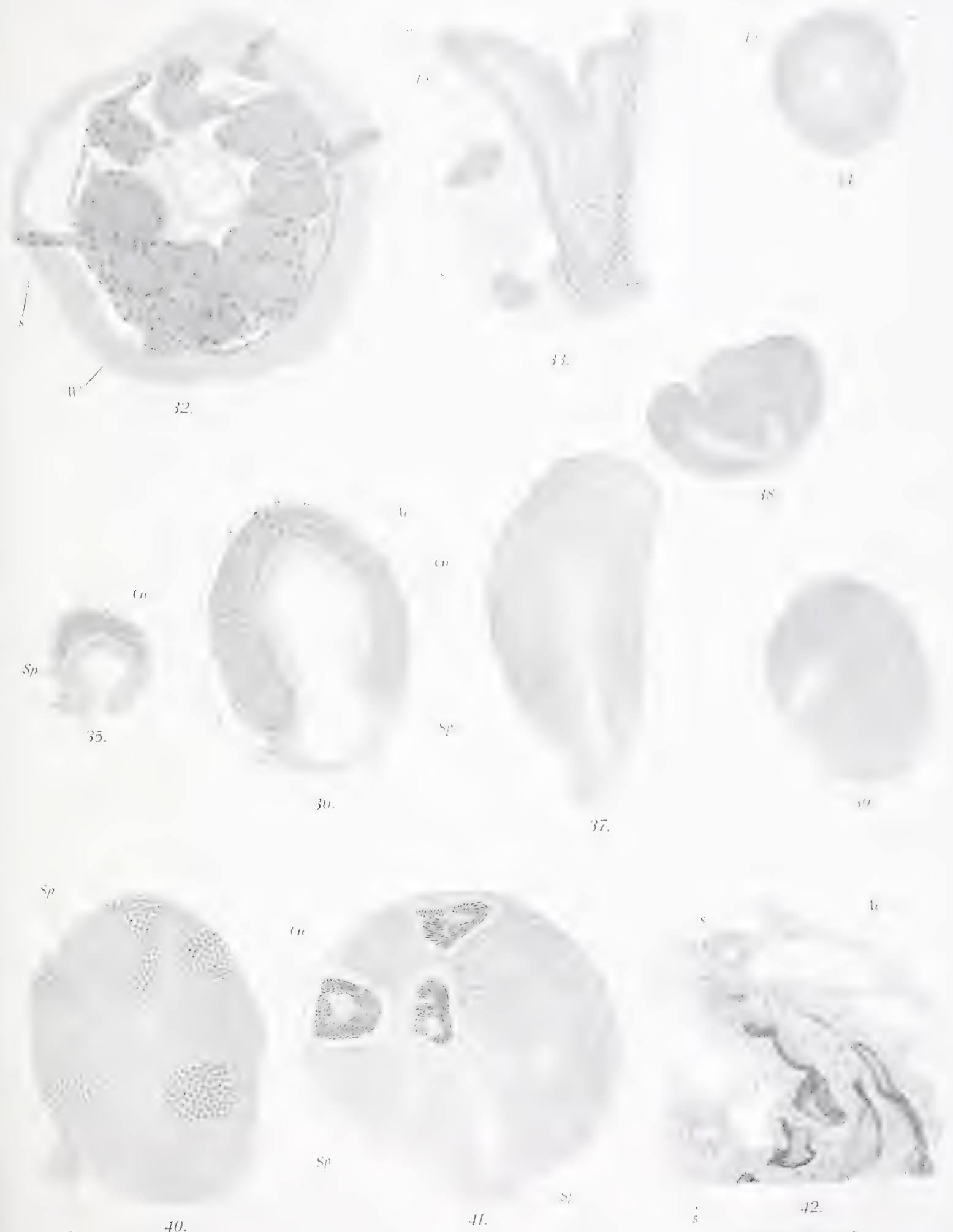


Plate V.

Plate V.

- Fig. 43. Apex of a gonophore (♂) in *Stylaster rosens*, containing spermatocytes in process of transformation. $450\times$.
- 44. Early stage in the development of a seminal duct in *Stylaster norvegicus*. $450\times$.
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49. Transverse section of the spadix close beneath the ovum in *Stylaster gemmascens*. $130\times$.
- 50. Median longitudinal section through a gonophore with advanced planula larva in *Stylaster gemmascens*. $130\times$.



THE INGOLF-EXPEDITION

1895—1896.

THE LOCALITIES, DEPTHS, AND BOTTOMTEMPERATURES OF THE STATIONS

Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom- temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom- temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom- temp.
1	62° 30'	8° 21'	132	7°2	24	63° 06'	56° 00'	1199	2°4	45	61° 32'	9° 43'	911	1°1
2	63° 04'	9° 22'	262	5°3	25	63° 30'	54° 25'	582	3°3	46	61° 32'	11° 36'	7	1°1
3	63° 35'	10° 24'	272	0°5		63° 51'	53° 03'	136		47	61° 32'	13° 40'	950	1°1
4	64° 07'	11° 12'	237	2°5	26	63° 57'	52° 41'	34	0°6	48	61° 32'	15° 11'	1150	1°1
5	64° 40'	12° 09'	155			64° 37'	54° 24'	109		49	62° 07'	15° 07'	1120	1°1
6	63° 43'	14° 34'	90	7°0	27	64° 54'	55° 10'	393	3°8	50	62° 43'	15° 07'	1020	1°1
7	63° 13'	15° 41'	600	4°5	28	65° 14'	55° 42'	420	3°5	51	64° 15'	14° 22'		1°1
8	63° 56'	24° 40'	136	6°0	29	65° 34'	54° 31'	68	0°2	52	63° 57'	13° 32'		1°1
9	64° 18'	27° 00'	295	5°8	30	66° 50'	54° 28'	22	1°05	53	63° 15'	15° 07'		1°1
10	64° 24'	28° 50'	788	3°5	31	66° 35'	55° 54'	88	1°6	54	63° 08'	15° 40'		1°1
11	64° 34'	31° 12'	1300	1°6	32	66° 35'	56° 38'	318	3°9	55	63° 33'	15° 02'		1°1
12	64° 38'	32° 37'	1040	0°3	33	67° 57'	55° 30'	35	0°8	56	64° 00'	15° 09'		1°1
13	64° 47'	34° 33'	622	3°0	34	65° 17'	54° 17'	55		57	63° 37'	13° 02'		1°1
14	64° 45'	35° 05'	176	4°4	35	65° 16'	55° 05'	362	3°6	58	64° 25'	12° 09'		1°1
15	66° 18'	25° 59'	330	—0°75	36	61° 50'	56° 21'	1435	1°5	59	65° 00'	11° 16'		1°1
16	65° 43'	26° 58'	250	6°1	37	60° 17'	54° 05'	1715	1°4	60	65° 09'	12° 27'		1°1
17	62° 49'	26° 55'	745	3°4	38	59° 12'	51° 05'	1870	1°3	61	65° 03'	13° 06'		1°1
18	61° 44'	30° 29'	1135	3°0	39	62° 00'	22° 38'	865	2°9	62	63° 18'	19° 12'		1°1
19	60° 29'	34° 14'	1566	2°4	40	62° 00'	21° 36'	845	3°3	63	62° 40'	19° 05'		1°1
20	58° 20'	40° 48'	1695	1°5	41	61° 39'	17° 10'	1245	2°0	64	62° 06'	19° 00'		1°1
21	58° 01'	44° 45'	1330	2°4	42	61° 41'	10° 17'	625	0°4	65	61° 33'	19° 00'		1°1
22	58° 10'	48° 25'	1845	1°4	43	61° 42'	10° 11'	645	0°05	66	61° 33'	20° 43'		1°1
23	60° 43'	56° 00'	Only the Plankton-Net used		44	61° 42'	9° 36'	545	4°8	67	61° 30'	22° 30'		1°1

Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom- temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom- temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom- temp.
68	62° 06'	22° 30'	843	3°4	92	64° 44'	32° 52'	976	1°4	118	68° 27'	8° 20'	1060	—1°0
69	62° 40'	22° 17'	589	3°9	93	64° 24'	35° 14'	767	1°46	119	67° 53'	10° 19'	1010	—1°0
70	63° 09'	22° 05'	134	7°0	94	64° 56'	36° 19'	204	4°1	120	67° 29'	11° 32'	885	—1°0
71	63° 46'	22° 03'	46			65° 31'	30° 45'	213		121	66° 59'	13° 11'	529	—0°7
72	63° 12'	23° 04'	197	6°7	95	65° 14'	30° 39'	752	2°1	122	66° 42'	14° 44'	115	1°8
73	62° 58'	23° 28'	486	5°5	96	65° 24'	29° 00'	735	1°2	123	66° 52'	15° 40'	145	2°0
74	62° 17'	24° 36'	695	4°2	97	65° 28'	27° 39'	450	5°5	124	67° 40'	15° 40'	495	—0°6
	61° 57'	25° 35'	761		98	65° 38'	26° 27'	138	5°9	125	68° 08'	16° 02'	729	—0°8
	61° 28'	25° 06'	829		99	66° 13'	25° 53'	187	6°1	126	67° 19'	15° 52'	293	—0°5
75	61° 28'	26° 25'	780	4°3	100	66° 23'	14° 02'	59	0°4	127	66° 33'	20° 05'	44	5°6
76	60° 50'	26° 50'	806	4°1	101	66° 23'	12° 05'	537	—0°7	128	66° 50'	20° 02'	194	0°6
77	60° 10'	26° 59'	951	3°6	102	66° 23'	10° 26'	750	—0°9	129	66° 35'	23° 47'	117	6°5
78	60° 37'	27° 52'	799	4°5	103	66° 23'	8° 52'	579	—0°6	130	63° 00'	20° 40'	338	6°55
79	60° 52'	28° 58'	653	4°4	104	66° 23'	7° 25'	957	—1°1	131	63° 00'	19° 09'	698	4°7
80	61° 02'	29° 32'	935	4°0	105	65° 34'	7° 31'	762	—0°8	132	63° 00'	17° 04'	747	4°6
81	61° 44'	27° 00'	485	6°1	106	65° 34'	8° 54'	447	—0°6	133	63° 14'	11° 24'	230	2°2
82	61° 55'	27° 28'	824	4°1		65° 29'	8° 40'	466		134	62° 34'	10° 26'	299	4°1
83	62° 25'	28° 30'	912	3°5	107	65° 33'	10° 28'	492	—0°3	135	62° 48'	9° 48'	270	0°4
	62° 36'	26° 01'	472		108	65° 30'	12° 00'	97	1°1	136	63° 01'	9° 11'	256	4°8
	62° 36'	25° 30'	401		109	65° 29'	13° 25'	38	1°5	137	63° 14'	8° 31'	297	—0°6
84	62° 58'	25° 24'	633	4°8	110	66° 44'	11° 33'	781	—0°8	138	63° 26'	7° 56'	471	—0°6
85	63° 21'	25° 21'	170		111	67° 14'	8° 48'	860	—0°9	139	63° 36'	7° 30'	702	—0°6
86	63° 03'	23° 47'6	76		112	67° 57'	6° 44'	1267	—1°1	140	63° 29'	6° 57'	780	—0°9
87	63° 02'3	23° 56'2	110		113	69° 31'	7° 06'	1309	—1°0	141	63° 22'	6° 58'	679	—0°6
88	64° 58'	24° 25'	76	6°9	114	70° 36'	7° 29'	773	—1°0	142	63° 07'	7° 05'	587	—0°6
89	64° 45'	27° 20'	310	8°4	115	70° 50'	8° 29'	86	0°1	143	62° 58'	7° 09'	388	—0°4
90	64° 45'	29° 06'	568	4°4	116	70° 05'	8° 26'	371	—0°4	144	62° 49'	7° 12'	276	1°6
91	64° 44'	31° 00'	1236	3°1	117	69° 13'	8° 23'	1003	—1°0					



19

THE DANISH INGOLF-EXPEDITION.

VOLUME V.

6.

HYDROIDA.

(PART I.)

BY

HJALMAR BROCH.

WITH 2 PLATES AND 20 FIGURES IN THE TEXT.



1965-42
11:6:25-

COPENHAGEN.

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1916.

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Preface.

The investigation of the large Danish collections of hydroids from the Faroe Islands, Iceland, and Greenland, and the researches into the interesting material brought home from the Ingolf Expedition, have realised great results. In fact, several points of dispute as to the classification of northern species have been settled. In the first place, the Danish collections contain original specimens of some species which have been described as new several times after being originally recorded. In other cases, the large number of specimens tend to bridge the division between species which have hitherto been looked upon as "good" ones. It is, indeed, a matter of regret that deficiencies of diagnosis and inaccuracy of design have frequently put obstacles to the recognition of species previously recorded, and that the literature has, consequently, been encumbered with synonyms which we should rather have done without. This inconvenience, in fact, enforces the necessity of giving full and exhaustive accounts of every single species. The American investigators, indeed, on the pattern of Nutting have long tried to give brief diagnoses and drawings of all American species. But it must be observed that, because of the impressionist way of drawing, the illustrations are, as a general rule, somewhat wanting in accuracy, and to the brief diagnoses there is the objection that they are often too summary to give exhaustive account of the distinguishing features. On the whole such weak points as appear in the last works of Allman, have gone down to his epigones. Great difficulties, indeed, are in this way given to students of the geographical distribution of the hydroids. No doubt, more species than those which are at present pointed out by literature, are common to the European and the American seas. But in general it proves impossible to form, on the ground of the brief diagnoses, a well-founded opinion as to the virtual qualities of many species. As far as the European species are concerned, we are fortunate in possessing the classic work of Hincks, *A History of the British Zoophytes*. However, since the appearance of that work, plenty of fresh subjects have been added by descriptions of several species and genera which can hardly all be maintained, and publications have of late appeared in such abundance that it proves difficult to students of this group of animals to find their way through the crowded matter.

These are the reasons why I have tried to give new and detailed diagnoses of every single species in question. The diagnoses are essentially founded on the copious material occurring in the Danish collections. Of synonyms I have only selected those of absolute necessity. Detailed accounts of synonymy are found — as far as earlier literature is concerned — in the excellent treatises of Bedot,

Matériaux pour servir à l'histoire des Hydroïdes, and — regarding recent literature on northern hydroids — in the groupings framed by Jäderholm (1909), Broch (1909), and Kramp (1914). As far as possible, the various species are accompanied by maps illustrative of the geographical data in the northern Atlantic. Besides the collections the recent literature has served as basis. In this respect the groupings occurring in the works of Bonnevie (1899), Jäderholm (1909), Broch (1909), Sæmundsson (1911), and Kramp (1914), have proved particularly available.

I have made it a point to define precisely the limits of genera and families by full diagnoses, and at the same time I have tried to account for the leading principles I hold to for the purpose of division and classification. The various authors have maintained various opinions as to the systematic principles of classification; many of them have disregarded phylogeny and allowed biological considerations to play a predominant part; consequently the circumscription of genera has been practised in most various ways. To leave no opening for misunderstanding I have thought it necessary to give a detailed account of each species in question, even if the work should be delayed and grow a little broader than I wanted. However, I hope that in this way the extensive and methodical Danish collections will tell better and to fuller advantage than otherwise.

Trondhjem the 22nd August 1915.

I. Introductory Notes.

Scarcely in any other part of the animal world greater difficulties are thrown in the way of the systematist than those occasioned by the lowest Coelenterata, impeding the attempts to establish a natural grouping of the hydroids and their attendants, the hydromedusæ. This is due not only to the actual deficiencies of our knowledge of these low organisms, but also to the fact — as pointed out by Kühn in his excellent summary (1913) — that the groups present partly a confused series of adaptations and phenomena of convergency, partly the occurrence of medusæ of widely divergent development as companions of closely allied hydroids or, vice versa, closely allied medusæ accompanying hydroid polyps divergently developed. It is a striking fact that in certain species, for instance the *Codonidæ*, the phylogenetic development and differentiation of form of the medusæ have been comparatively stunted, whereas the polyps (*Corynidæ*, *Pennariidæ*, *Tubulariidæ*) have developed heterogeneously so as to present a large series of various forms. The exact reverse is represented by the homogeneous polyps of the family *Bougainvilliidæ* forming the nurse generation of the heterogeneously developed hydromedusæ of the families *Margelidæ* and *Tiaridæ*. The possibility of constructing a safe system common to medusæ and hydroid polyps, indeed, appears remote. For in the first place the two “generations”, on account of their excessive abundance of species, have had to be treated separately, each generation by specialists of its own, and moreover, we are in fact still in the dark as to which of the two generations is to be regarded as the primitive or the phylogenetically older.

When looked upon as a whole the group of Zoophytes must be characterized as a very low group of animals. In the nurse generation as well as in the free-swimming medusæ the structure of the individual is very simple, though the medusæ after all must be said to be a little higher organised than the polyps. In addition to the two primary layers of cells, the endoderm and the ectoderm, occurs in the medusæ a “mesogloea”, whose descent from one or the other of the primary layers is not yet definitely ascertained as far as all species are concerned. However, a mesogloea also occurs with some hydroids, for instance the “parenchyma” of the *Tubulariidæ*, which is a typical endodermal formation.

To students of the hydroids it very soon becomes obvious that the leading systematic characters have been derived from such criteria as urge themselves on a superficial view of the animals, while, contrarily to the method practised in investigating most other groups of animals, the inner anatomy is all but entirely left out of account. This is due to the generally accepted view that the

structure of the hydropolyps is throughout quite homogeneous and accordingly affords no holds of use to the systematist. A careful study, however, of the slight information occurring in the literature as to the structure of the polyps, will show that the old view is wrong. In this connection it will be sufficient to refer to the excellent passage written by Kühn (1913), *Die Ausbildung des Polypenkörpers*, in which are mentioned several examples of the heterogeneous structure of the polyps in the various groups of hydroids.

Nevertheless Kühn himself (1913), in constructing his system of the hydroids, has, according to the old practice, left this fact almost wholly out of account. I will afterwards come back to the subject and point out how unreasonable it is to set aside this part of systematics even though a thorough investigation of the anatomy of the polyps may seem almost impracticable because of the state of preservation in which the hydroids generally occur in the materials of the great expeditions and collections. In fact, it is confirmed that Levinsen (1893) is right, emphasizing that the systematist in treating of hydroids should rather lay stress on all about the nourishing individuals than on the varying development and organisation of the generative individuals.

a. The Hydroid Gonophores bearing on classification.

Our knowledge of the hydroids has advanced a vast stride ahead owing to the thorough researches of Kühn into the development and the organisation of the gonophores (1910). As to the importance of the gonophores to systematics, it has lately (1913) been asserted by the same author that no weight whatever can be given to the various gonophoral development, but that particular stress should be laid on the structure of the full-grown gonophores. On account of difference of structure he distinguishes between four types of sessile gonophores: eumedusoids, cryptomedusoids, heteromedusoids, and, finally, the simple gonophores, called styloids (Bonnievie 1898). The eumedusoid gonophores, indeed, retain the structure of the medusa throughout, and occasionally breaking away (*Campanularia integra* Mc. Gillivr. — *Agastrea mira* Hartlaub) occur like defective medusæ. The structure of the cryptomedusoid gonophores is more reduced. Certainly they keep their endocodon and their umbrellary cavity, but have a single-layered umbrellary endoderm; however, also of cryptomedusoids occur exceptional instances breaking away, as in *Pachycordyle Weismanni* Hargitt. The heteromedusoids are entirely wanting the umbrellary endoderm, and the inner umbrellary ectoderm is formed by delamination, not by invagination of the outer ectoderm (endocodon). The simplest gonophores, finally, are without any trace of medusoid organisation. These four types of sessil gonophores Kühn (1913) regards as characters important to the systematist for the division of hydroids into genera.

Stechow (1913) in his important work on Japanese hydroids occupies another standpoint, attaching more importance to the conditions of the gonophores. Thus he draws nearer to earlier principles of classification, but at the same time he tries to make his systematic division more manageable by drawing out characters from the outward morphology of the colonies, thus effecting the transition to the American school. The Americans, headed by Nutting, look on classification only as "a matter of convenience", and accordingly in their groupings, as a matter of fact, relinquish the idea of constructing a natural system aiming at summing up and drawing by critical sifting of the characters a skeletonlike picture of the phylogenetic affinities of the group of animals in question. Con-

sequently the system brought about by the American investigators, picking up heterogeneous characters, is indeed, as I have shown in an earlier treatise (1909), to a great extent one of arbitrariness, placing the species now in one, now in another genus, according to the character it is thought desirable to emphasize at the moment. The system has, in this way, become a matter of chance.

Before proceeding to the special explanation of the several species of hydroids and their occurrence in the seas of the northern Atlantic, we, therefore, must try to realize, from a systematic and phylogenetic point of view, the value of each single character. In the first instance the question must be answered what part the gonophores play as to the phylogeny of the hydroids or, in other words, what importance has to be attached to the gonophores and their conditions for the purpose of classification.

The application of the characters of the gonophores as distinguishing marks of higher systematic unities, of families, or of subfamilies, has been abandoned by all modern investigators of the hydroids. On the other hand, it is held by several investigators that they are of importance as to the limitation of genera. The last significant publications maintaining this view, are those of Kühn (1913) and Stechow (1913). Kühn, however, applies the characters of the gonophores with much caution and discretion, while Stechow, as a glance at his tables (1913, p. 36 and the following pages) suffices to show, undiscerningly recurs to the principle of laying the main stress on the "medusa" as contrasted with the "sporosac". In fact, as long as the limits between these designations are not more precisely defined, they will be subject to much arbitrariness. An interesting instance is afforded by the point in dispute, where the limits are to be drawn between the genera *Coryne* and *Syncoryne*. The old criterion, accepted by Allman and other investigators, was the free medusa as contrasted with the fixed gonophore or sporosac, and, to all appearance, it is the same limitation Stechow tries to maintain in his table. Indeed, this principle of limitation was only supportable on the ground of the deficient knowledge of the organisation and development of the hydroid gonophores attained to in Allman's days. Kühn, therefore, (1913, p. 229) is seen to take quite another departure, defining the *Syncoryne* as including all species having "medusæ", while the *Coryne* is distinguished by styloid gonophores. It is evident from Kühn's previous argument (l. c. p. 174) that under "medusæ" he also includes the eumedusoids which normally do not break loose, and that accordingly *Coryne*, in his opinion, exclusively embraces species having styloid gonophores.

Parallel to these genera Stechow also treats of *Podocoryne* (with medusæ) and of *Hydractinia* (with "sporosacs"). Kühn (1913, p. 227) groups them in the following vague way:

<i>Podocoryne</i>	} Medusen (Margelinen), Eumedusoide, Cryptomedusoide, Styloide.
<i>Hydractinia</i>	

From his premises (l. c. p. 226) it appears that he agrees with most modern investigators, thinking it right that the two old genera should be merged into one, *Hydractinia*; for he states that in fact we have here before us a series of closely allied forms, in which "zwischen Arten mit Vollmedusen und einfachen Medusoiden die verschiedensten Übergänge bestehen". Thus Kühn, elsewhere considering the characters of the gonophores as significant generic criteria, in this place actually reduces them to mere specific characters.

In another connection Kühn (1913 p. 197) gives an instance of the fact that the sexes in

one and the same species can be distinguished by different types of gonophores; thus the female gonophore of *Laomedea flexuosa* Hincks is heteromedusoid, while the male gonophore is styloid. This strongly defined sexual dimorphism is most interesting, and the question is obvious whether the case is a solitary one, or if in other species other types of gonophores, of those stated by Kühn, might perhaps be found united in one and the same species. On that account I have (1915) more closely examined the development of the gonophores of, among others, the *Tubularia indivisa* Lin. and the *Tubularia regalis* Boeck, two species in which a marked sexual dimorphism is found pronounced in the external characters of the gonophores. The examinations resulted in the startling result that the female gonophores of both species are eumedusoid, though not equally high in medusoid organisation, whereas the male gonophores of both species are heteromedusoid and of entirely the same organisation and development as the gonophores of the genus *Lampra* Bonnevie (1898) (comp. Broch 1915). It is owing to the gonophores that *Lampra* is separated from *Corymorpha*, the latter genus producing free medusæ or having gonophores eumedusoid. Acting on this principle of division, as far as the species of the genus *Tubularia* are concerned, we should have to separate the male *Tubularia indivisa* and *Tubularia regalis* as a new genus, while the female individuals belonging to the same species would retain their places¹.

The outcome of the searching studies of the last years shows, indeed, that in proportion as a greater number of species have been examined, the more evidently the characters of the gonophores appear as criteria of species. The increasing knowledge of the gonophores makes ever clearer that the gonophores alone cannot form the base of any division of genera, but at most serve as secondarily corroborative.

The free medusæ show throughout a greater abundance of forms developed than the polyps, which are more conservative. No doubt, the medusæ present a series of phenomena of adaptation and, accordingly, display several characters of convergency, to which the systematists are inclined to attach a greater phylogenetic value than is their virtual due. Nowhere, I dare say, the adaptations to habits of life and the accommodations to varying physical conditions play such a part as with the pelagic organisms, to which the slightest variation of salinity and of temperature causes great changes of viscosity of the surrounding water, decisive of the adaptation of their suspension organs. Therefore, the hydroid systematist should not lay too much stress on the statements of the medusoid specialist as to the systematic grouping of the free-swimming generation; phylogenetically the characters of the nurse generation are of the greatest interest. A similar state of things urges itself with the sessile gonophores. It is a circumstance of vital importance to the maintainance of the species, that the generative individuals are able to accommodate themselves quickly to the peculiar conditions of life to which the species is subjected. What I observed in my treatise on the *Stylasteridae* (1914), is fully applicable (or even more so) to the case under consideration: "Owing to their conservatism in development the polyps are of the most important phylogenetic interest. The gonophores, the generative individuals, on the other hand, might almost be said to be a playball in the hands of chance biological conditions and thus phylogenetically have much less interest".

¹ The possibility of a fusion of four species is precluded, as in *Tubularia indivisa* and in *Tubularia regalis* ♂ and ♀ occur in the same colony.

On account of their dependence on outward conditions and their power of plastic accommodation to biological influences, the gonophores are unsuitable for basis of division into genera. On the other hand, the genera, owing to the conditions of the gonophores, often fall into a series of biological groups (or subgenera). The systematists who lay the main stress on the gonophores in establishing the system, in fact apply biological conditions as fundamentum divisionis, and let phylogeny, the properly governing principle of systematic inquiry, recede into the shade.

b. The comparative anatomy of the nourishing individuals, and the system of the athecate hydroids.

An exact review of the researches of the last years makes ever clearer, as also appears from the statements above, the correctness of Levisen's view (1893), maintaining that in the great classification of the hydroids the main stress must be laid on the peculiar conditions of the nourishing polyps, and reducing at the same time the modifications of growth and the conditions of the gonophores as characters of subordinate importance. Later investigators¹ have, indeed, attached ever more importance to the conditions of the polyps. But in so doing they have almost exclusively taken into consideration such morphologic criteria as urge themselves on a superficial view of the polyps. The inner anatomy, on the contrary, has been disregarded. Kühn (1913) certainly by the way points out that the inner anatomy can be different in the different groups. He treats (l. c. p. 50) at some length of the peculiar structure of the polyps of the *Tubulariidae*, and points out the multifarious development of the *thecaphores*. But in drawing the bases of his system he makes no attempt to turn these features to further account.

As a result of searching inquiries, the structure of the polyps in the different genera and families has turned out not to be quite so homogeneous as it has been generally held. Both in the construction of the ectoderm and in that of the endoderm differentiations occur, which may be characteristic of greater or smaller groups of species and give us several holds for judging the systems drawn up for hydroids in the course of time.

Therefore, it will here be appropriate to give a brief synopsis of the more important peculiarities of anatomy distinguishing the various groups of athecate hydroids, in order to apply them afterwards to drawing up the system of the group.

The *ectoderm*, deciding by the disposition of its elements whether the tentacles have to be claviform or not, has, to some extent, been turned to account as fundamentum divisionis. The claviform shape is particularly due to the accumulation of the stinging cells on the tips of the tentacles, while the tentacles are filiform when the nematocysts are more equably distributed. A third type of tentacles, which, as far as is known, is found with all thecaphore hydroids, occurs in the *Eudendriidae*;

¹ Works like that of Poche (1914) I leave out of account. That sort of "zoology" which is based not on study of the organisms themselves, but only on what may be beaten up from books, here debouches in the construction of airy castles of complicated systematics, which does not advance zoological science by a hairbreadth, but only contributes to increasing the systematic confusion. Between "regnum" and "family" are inserted 34 — thirty four — degrees. It is a matter of regret that we do not learn how many osculant categories must be placed between "family" and "individual" to give a "full" picture of nature. But this will suffice to illustrate the scientific value of the work.

here the stinging cells are arranged in dense transverse belts round the tentacles so as to give these, when distended, a peculiar transversely striped appearance.

On the ground of filiform and claviform tentacles Kühn (1913) divides the athecate hydroids into the two principal groups of *Filifera* and *Capitata*. However, we find in the latter group also instances of filiform tentacles; in the *Pennariidae* filiform tentacles occur together with claviform ones; in the *Tubulariidae*, on the contrary, the claviform tentacles have disappeared, at any rate in the polyps fully developed. Kühn (l. c. p. 228), therefore, also makes the reservation that the tentacles are "dauernd oder in der Jugend geknüpft". Embryological studies on *Corymorpha* have, in fact, shown that the actinula has claviform tentacles (Torrey 1907, Hartlaub 1907). However, this state of things cannot be generalized as a matter of course to embrace the *Tubularia*; on the contrary the figures of Allman (1872) show quite distinctly that the actinula in *Tubularia larynx* and *Tubularia indivisa* have filiform tentacles, and inquiries into the *Tubularia regalis* in the Trondhjem Fjord have shown no trace of capitate tentacles during the development of the actinula. Nor do here claviform tentacles occur in full-grown polyps.

But even though the definition of Kühn must be characterized as erroneous so far, there is another criterion showing that his division of groups is correct. A searching study of the very nematocysts, shows, as a matter of fact, that the athecate hydroids fall into two large principal groups, corresponding to the *Capitata* and the *Filifera* stated by Kühn.

In the hydroids occur two characteristic principal forms of nematocysts (Pl. I, figs 1—7). In all the *Capitata* we find large oviform or almost wholly spherical nematocysts of the same principal type as is often mentioned in the *Hydra*. These large nematocysts are always accumulated on the tips of the claviform tentacles, as in the *Coryne*, while on the filiform tentacles of the *Tubularia* they are more equably distributed all over the ectoderm of the tentacles. However, these stinging capsules are also found elsewhere in the ectoderm of polyps, as is the case with *Monocoryne* and *Myriothela*. In the last mentioned form the nematocysts, like those of *Millepora*, have developed dimorphically; besides the typical oviform nematocysts we find here a larger and more slender oval form; in general the latter nematocysts are outnumbered by the oviform ones, but still they amount to a large percentage of the total stock of stinging capsules occurring in the animal. In the *Millepora* this type of nematocysts, judging from the figures in hand, is rather broad.

The rest of the hydroids are distinguished by quite a different type of nematocysts. The predominant type is a very small, all but rod-shaped nematocyst, particularly occurring in the tentacles, generally accumulated in belts, vertically on the tentacle axis, giving the tentacles, when wholly stretched out, a peculiar transversely striped appearance, like that of the tentacles of the *Eudendrium* recorded. Concurrently with this typical small nematocyst distinguishing all *Filifera* sometimes occurs, finally, a somewhat larger form, as in the *Eudendrium* and the *Stylasteridae*. In the *Eudendrium Wrighti* we find in the tentacles only small rod-shaped stinging capsules; on the contrary in the basal whorl of stinging cells of the polyp body of the species in question the capsules are much larger, though keeping a slenderly oval appearance. It is strange that this large type of the *Eudendrium* and the *Stylasteridae* should appear almost entirely consistent with the aberrant slenderly oval nematocyst with the *Myriothela*. The simultaneous occurrence of the type in so different and so highly

organised forms suggests, indeed, that we have before us phenomena of convergency, the cause of which is at the moment quite inexplicable.

However, not only the ectoderm itself and its elements are of interest to comparative anatomy. The derivatives of the ectoderm are of great importance. In the same way as the ectoderm of the stem secretes a periderm, we find that with all thecaphore hydroids a chitinous hydrotheca is secreted by the ectoderm of the polyp. Remarkably enough, a parallel is found also in a single genus of the athecate hydroids, the *Perigonimus*. In this genus the ectoderm of the polyp secretes a "pseudohydrotheca", a hydrotheca-like, folding periderm case of a jellied substance surrounding the basal portion of the polyp up to the tentacle whorl. The first inquiries as to the pseudohydrotheca have been made by Hadži (1913 and 1914). The pseudohydrotheca is distinguished from the real hydrotheca in having no free margin, but being distally firmly connected with the ectoderm of the polyp so as to be indistinguishable, on a superficial view, when the polyp is wholly distended. On the contrary, when the polyp is contracted, the pseudohydrotheca is, in general, easily discerned, forming a richly folded cover round the basal portion. The pseudohydrotheca bears some resemblance to the genuine hydrotheca by the way in which the polyp is attached to it, the supporting lamella of the polyp being basally connected with the pseudohydrotheca by a whorl of small chitinous prominences. Similar chitinous prominences are also seen, for instance in *Endendrium*, connecting the soft parts of the stem with the periderm cover; systematically, however, no particular interest can be attached to them.

Also in the endoderm diversities of great interest are found. The simplest, most homogeneous shape is represented by the gastric endoderm of *Clava* (Broch 1911), forming a homogeneous epithelium for absorbing the nourishment, from the orifice of the mouth to the passage of the polyp into the stem; almost all of the cells of the gastric endoderm are filled with larger or smaller grains showing a strong affinity to Delafield's hæmatoxyline ("nutritive cells" and "albumen cells", comp. Schneider 1902). As to *Coryne*, the state of things is quite different; here the endoderm in the portion nearest to the mouth is extremely rich in mucous gland cells, while the digestive cells are comparatively few in number. In *Coryne* we must consequently distinguish between the oral portion secreting mucus and the part of the endoderm of the polyp which is the proper gastric or digestive portion. The difference between these two endodermal zones appears still more distinctly in *Myriothele*; the glandular cells are here densely concentrated on a small portion near to the mouth, strongly conspicuous by its clear blueing after being treated with Delafield's hæmatoxyline; the other endodermal cellular forms have almost wholly disappeared in the glandular zone with *Myriothele*. In *Tubularia*, on the contrary, the glandular zone has disappeared, so that the endoderm here by its homogeneous appearance all over the polyp strongly recalls the case of *Clava*.

A rather different state of things is found in the *Bougainvilliidae*. Here, indeed, mucous cells, occur in the oral endoderm of the polyp. But the bulk of the cellular elements in the oral portion as far as the whorl of the tentacles, is constituted by cells which appear indifferent to the nutritive elements. All the cells here have small nuclei strongly concentrated, while in the gastric endoderm taking the nourishment, from the whorl of tentacles and downwards, the nuclei are large, with open chromatinic net-work. This condition of things is still more pronounced in *Endendrium*, the mucous cells of

which, however, are most frequently concentrated in the proboscis, closely to the basis of the tentacles, where the entrance to the proper gastric cave is found.

Thus there is throughout a typical difference between the *Capitata* and the *Filifera* as to endodermal matters, though the *Clava* apparently presents an intermediate form or a form of departure from which the other types are derivable. Simultaneously the *Filifera*, as far as can be judged from the data in hand, bear a typical resemblance to the thecaphore hydroids, and here the parallel between the *Eudendrium* and the *Campanulariidae* is particularly obvious. Whether this is owing to a closer affinity or it must be explained only as a phenomenon of convergency, we must at present leave unanswered, because of our deficient knowledge of the group.

A single family, the *Tubulariidae*, shows an anatomic peculiarity, as with the species of this family there occurs a peculiar mesogloeal formation. At the basis of the large tentacles the endoderm has developed a thick supporting cushion formed as a ring of mesogloeal tissue of large cells round the polyp. This leans inwardly on the supporting lamella, and is bounded against the axial endoderm of the tentacles by a delicate membrane, which in some cases it is rather difficult to point out.

Hollow tentacles occur in two ways. In their original shape they are, as is the case with *Hydra*, openly communicating with the gastric cave of the polyp. This state of things, however, has ceased with most hydroids and cannot be found in any of our northern species. In these, on the other hand, occasionally occurs, as in *Clava multicornis* and in *Myriothela* a central cavity in the tentacles, at any rate in their basal part. This cavity, however, does not communicate with the gastric cave of the polyp, but is basally bounded by the unbroken supporting lamella. This central cavity of the tentacles, as it is represented by well-developed *Clava multicornis*, might be looked upon as a primitive condition of things. However, in forms so highly organised as *Myriothela*, it must sooner be considered as a secondary phenomenon, which cannot have any direct correspondence with the primitive condition of things in *Hydra*.

In *Myriothela* the tentacles show a peculiar structure, elsewhere unknown in the hydroids. The matter is more precisely described by Jäderholm (1905). The supporting lamella is in the thickened distal part of the tentacle transformed into a cushion constructed by delicate radially placed fibres, showing no cellular structure and densely crowded. They seem to be intended for strongly stiffening the distal portion of the tentacles and for making the armed outmost portion of the tentacles larger and more powerful of resistance.

On the ground of the anatomical features stated, and of morphological characters hitherto turned to account in systematics, is brought about a system which, as far as the athecate hydroid families are concerned, can be summed up in the following key of determination:

- A. No formation of gonophores. Eggs and sperms, developed in the wall of the polyp. The tentacles — if such ones occur — hollow, openly communicating with the gastric cave (Sectio **Simplicia** nov.) Fam. *Hydridae*.
- B. The generative cells developed in special gonophores.
 - I. The polyps with large, broadly oval or spherical nematocysts (Sectio **Capitata** Kühn).
 - a. The tentacles of the polyp wholly or in part claviform.

- 1) The polyp having only one kind of nematocysts. The claviform tentacles of simple structure, having no central cavity and no particularly developed supporting lamella.
 - a.* All tentacles claviform. Fam. *Corynidae*.
 - β.* The distal tentacles claviform; proximally a whorl of filiform tentacles. Fam. *Prunariidae*.
 - 2) The polyps, besides having oviform or spherical nematocysts, also provided with slenderly oval or nearly cylindrical stinging capsules.
 - a.* Without calcareous skeleton. The claviform tentacles having a central cavity, greatly widened distally, but not openly communicating with the gastric cavity of the polyp. The supporting lamella, in the outer portion of the tentacles, developed into a thick radial fibrous supporting tissue. Fam. *Myriothelidae*.
 - β.* Colonies with calcareous skeleton. The tentacles of simple structure, having no central cavity. Fam. *Milleporidae*.
 - b. All the tentacles of the polyp filiform, arranged in two main circles:
 - 1) The proximal (basal) whorl of tentacles leaning against a well-developed mesogloal cushion. The polyps of radial symmetrical structure. Fam. *Tubulariidae*.
 - 2) The mesogloal formation at the basis of the proximal whorl of tentacles almost wanting, owing to radial canals. The structure of the polyps bilaterally symmetric. Fam. *Branchiocerianthidae*.
- II. The nematocysts always only slender, the small ones quite rod-shaped. (Sectio **Filifera** Kühn).
- a. Colonies without calcareous skeleton.
 - 1) The tentacles irregularly spread all over the polyp, or reducible to a single large tentacle. The endoderm not differentiated into oral endoderm and gastric endoderm. Fam. *Clavidae*.
 - 2) The tentacles forming a main circle round the polyp. The endoderm differentiated into an oral endoderm and a gastric endoderm.
 - a.* The polyps fusiform with conically pointed proboscis. Fam. *Bougainvilliidae*.
 - β.* The broad body of the polyp well defined from the stem, and provided with a claviform proboscis placed with a narrow basis on the whorl of the tentacles. Often two kinds of nematocysts, large ones and small ones. Fam. *Eudendriidae*.
 - b. Colonies with calcareous skeleton and with two kinds of nematocysts, the large ones being slenderly oval or nearly cylindric, frequently slightly curved. Fam. *Stylasteridae*.

II. Athecate Hydroids of the Northern Atlantic.

Section Capitata Kühn.

Family Corynidae.

"Hydroids with fusiform or more cylindric polypes, whose oral portion is conically pointed. The stinging capsules are large, oviform, or almost globular. All the tentacles of the polype are capitate with the stinging cells mainly concentrated on the thickened distal portion. The structure

of the tentacles is simple, with no central cavity, and with a thin supporting lamella without any particular thickening. In the endoderm we must distinguish between an oral portion, abounding in mucous gland cells, and the gastral portion proper. The colonies develop no calcareous skeleton.

It is questionable, as is also pointed out by Kühn (1913), whether it is justifiable to maintain the *Corynidae* and the *Pennariidae* as two distinct families. Stechow (1913) states that "das gleichzeitige Vorkommen geknöpfter und fadenförmiger Tentakel ein vorzügliches Merkmal für das Bestimmen ist"; simultaneously, however, he ranks the genera *Acaulis* and *Clavatella* with the *Corynidae*, though, having tentacles both capitate and filiform, they should, from this main characteristic, be reckoned among the *Pennariidae*. Also as compared with the *Tubulariidae*, the limitation of the *Pennariidae* makes some difficulty. Thus Bonnevie (1899) e. g. classes *Heterostephanus* among the *Tubulariidae* in spite of the fact that the species is provided with capitate distal tentacles. Stechow (1913), on the other hand, as well as Broch (1911), ranks this genus with the *Pennariidae*. I regret that I am in lack of material for a more thorough inquiry into the *Pennariidae*; it is not unlikely that the anatomical structure of the polypes might afford safer holds for the judging of this group of hydroids than the merely outward morphological characters.

The *Corynidae* form a very central group, with which all the other groups of the section of *Capitata*, stated by Kühn, are likely to have originated. — At the first glance it may appear as if one of the genera *Monocoryne* has got nematocysts heterogeneously developed, so as to show, besides oviform or globular capsules, partly also long, narrowly oval ones. That this is not the case, is ascertained by a careful study of material of *Monocoryne gigantea* (Bonnevie) collected in the Trondhjemsfjord. Partly all the nematocysts of this shape are discharged, and partly developmental stages of other nematocysts than oviform ones are not traceable. It is, therefore, obvious that, in being discharged, the oviform nematocysts assume a narrowly oval shape. The apparent dimorphism of the nematocysts would otherwise have been greatly interesting as a connecting link with *Myriothecla*, and would have been likely to support the supposition of Bonnevie (1899) of the derivation of the last-mentioned genus from the *Corynidae* through *Monocoryne*. But as a matter of fact, the large *Monocoryne gigantea* shows the anatomical structure of the true *Corynidae*. Swenander (1903) mentions that its tentacles are coalesced at the basis; this statement, however, only holds good for the ectoderm, which in several places appears to be stratified; the endoderm, as far as the single tentacles are concerned, continues, wholly surrounded by the ectoderm, to the supporting lamella. *Monocoryne gigantea* presents another peculiarity which the inquirers have hitherto obviously failed to notice; the individuals are hermaphrodite, in a most peculiar way. Not only we find in a single individual sheer female and sheer male gonophores; but among these also occur several gonophores containing, besides large ova, also sperms and spermatocytes of all stages. The gonophores of this species are reduced to cryptomedusoids.

In the internal structure of the polype of the *Corynidae* our attention is fixed on a great accumulation of mucous gland cells in the endoderm next to the orifice. Here are densely accumulated a lot of cells, whose affinity with Delafield's haematoxyline make them very conspicuous on material well preserved. This concentrated glandular zone is found still more strongly marked in the *Myrio-*

thelidae, whereas in the *Tubulariidae* it has disappeared. It forms a striking contrast to the proboscis of the *Eudendriidae*, the outer oral portion of which is more abounding in indifferent endodermal cells and more nearly approaching the state of things in the *Bougainvilliidae*, in which, however, also the indifferent endodermal cells appear in larger numbers. As is mentioned before, this oral zone is wanting both in the *Clavidae* and the *Stylasteridae*.

The *Corynidae*, like their near relations the *Myriothelidae*, are distinguished by a vigorously developed polype musculature, and in connection with this show an astonishing power of changing appearance and volume. It is easy for them to swallow a comparatively large copepod, and in my material I have found several shapeless-looking *Coryne*-polypes which were digesting rather large crustaceans. Thus they are very greedy animals, frequently feeding on organisms larger than the polype of normal size. Series of sections show how the food half dissolved also is led direct into the gonophores and is absorbed by their endodermal spadix. The endodermal cells of the spadix then are filled with some granulous contents, which are greedily absorbing and tenaciously keeping the haematoxyline of Delafield, while they are rather indifferent to both the haematoxyline of Böhmer and to eosine. However, the cells also contain several eosinophile grains.

Gen. *Coryne* Gaertner.

"*Corynidae* forming colonies, with solitary capitate tentacles spread all over the hydranth. The colony is formed by the ramification of an upright hydrocaulus, whose tubes do not communicate through secondary canals. The gonophores are developed on the proximal portion of the polypes".

Many investigators place the species productive of medusae in a separate genus, *Syncoryne*. This criterion, however, is of merely biological nature, and thus of less importance to systematists. And apart from this, it is evident that some species of *Coryne* produce more strongly reduced eumedusoids which are only quite exceptionally detached from the mother colony. The species have not yet been sufficiently examined. Therefore, it is obvious that, for instance, the species *Coryne Loveni* (M. Sars) must have been several times confounded with *Coryne Sarsi* (Lovén). In the medusoid gonophores of the former species the tentacles are wholly reduced, while *Coryne Sarsi* has complete medusoid gonophores with tentacles. The opinion maintained by L. Agassiz (1860) and Hincks (1868), based on the observations of L. Agassiz (l. c.) and Clark (1865), that some species of *Coryne* at one time of their lives produce free-swimming medusae, at other times, on the contrary, sessile eumedusoids, has not yet been refuted, but, quite the contrary, been strengthened by the observation of a parallel condition of things in species of *Campanularia* (Giard 1899, Behner 1914). It is not impossible that *Coryne Sarsi* should be one of these species of *Coryne*. In *Coryne Loveni* the eumedusoid gonophore has lost its tentacles, and at the same time the development of the generative cells shows us that the gonophores are not here normally disengaged from the colony. Other species, such as *Coryne Hincksi* Bonnevie and *Coryne brevicornis* Bonnevie, seem to have gonophores somewhat more reduced, still, however, keeping the medusoid structure strongly defined. These species, then, exhibit stages forming the transition to *Coryne pusilla* Gärtner with its strongly reduced styloid gonophores.

If we, therefore, like Kühn (1913) and Stechow (1913), separate *Syncoryne* as a genus of its own, there will be insurmountable difficulties about drawing the limits. If, as is done by Stechow, the limit is drawn by the production of free-swimming medusae, *Coryne Loveni* must normally be omitted from the genus *Syncoryne*, and a species such as *Coryne Sarsii* will probably have to be reckoned sometimes among the *Syncoryne*, at other times, on the contrary, among the *Coryne*. If, on the other hand, we follow Kühn and draw the limits of genera between species with eumedusoid gonophores and species having gonophores more strongly reduced, it may be greatly questionable where, for instance, *Coryne Hincksi* and *Coryne brevicornis* ought in fact to be placed. In this case as in others, the more species we learn to know more exactly, the more impossible it proves to draw the limits of genera on the ground of gonophoral conditions. To this must be added that in all the species of *Coryne* or *Syncoryne* the colonies and the polypes are so uniform as to their appearance, that they cannot with certainty be identified to species or included under one or the other of the two "genera", if the gonophores are wanting or only little developed. It is, therefore, absurd to insist on drawing an artificial and arbitrary line of distinction, founding on merely biological phenomena of adaption.

***Coryne Sarsii* (Loven) Johnston.**

1835 *Syncoryna Sarsii*, Loven, Bidrag til Kännedomen af Slägterna *Campanularia* och *Syncoryna* p. 275, pl. 8, fig. 1—6.

1847 *Coryne Sarsii*, Johnston. A History of the British Zoophytes, p. 43.

?1911 *Syncoryne Sarsii*, Sæmundsson, Bidrag til Kundskaben om de islandske Hydroider II, p. 72.

"The delicately constructed colonies attain to a height of up to 30 mm. The hydrocaulus is wholly irregularly ramified with no distinct main stem; the branches form acute angles with the stem or the main branch whence they proceed; both the stems and the branches are almost entirely smooth with no rings nor wrinkles. The strongly contractile polype, when extended, attains to a length of up to 1.5 mm., and is then almost wholly filiform; when contracted, it is oviform or nearly globular. The numerous capitate tentacles are irregularly distributed over the polype.

The gonophores develop into medusae, which are likely to break away during the greater part of the generative period of the polype; the medusa bud develops four tentacles. One or two, more rarely three, gonophores occur simultaneously on the polype".

Material:

Iceland, Reykjavik.

Shallow water (associated with small *Mytilus*).

In all probability, Sæmundsson (1902, 1911) is right in including these very delicately constructed colonies under *Coryne Sarsii*. The occurrence of the species is boreal. But the possibility that the species is frequently confused with forms nearly related, as yet precludes certain decision as to its distribution. *Coryne Sarsii* is recorded from the coasts of Norway, Bohuslän, Denmark, Helgoland, Great Britain, Iceland, and Northern France. Hartlaub (1905 a) and Jäderholm (1903), though with some doubt, refer some colonies from Tierra del Fuego and from Patagonia to the same species.

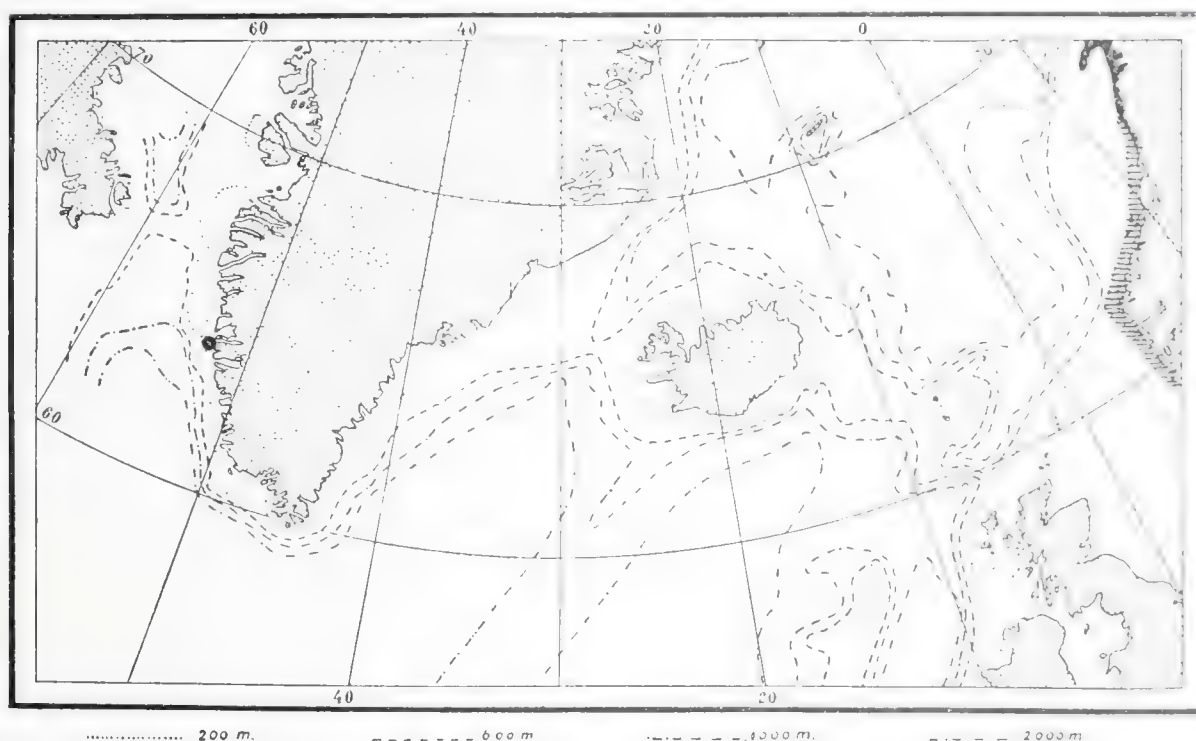
Coryne Loveni (M. Sars) Bonnevie.

1835 *Syncoryna ramosa*, Lovén, Bidrag til Kännedomen af Slägterna *Campanularia* och *Syncoryna*, p. 275, pl. 8, figs. 7—10.

1846 — *Loveni*, M. Sars, Fauna littoralis Norvegiae, p. 2, footnote.

1899 *Coryne Loveni*, Bonnevie, Norske Nordhavs-Expedition, p. 14.

"The colonies are rather coarsely constructed and attain a height of up to 30 mm. The hydrocaulus is wholly irregularly ramified and shows no distinct main stem. The branches proceed almost rectangularly from the stem or the mother branch, but at once curve upwards, forming a very acute angle or even a parallel with it. The hydrocaulus and the branches are almost entirely smooth, having only here and there wrinkles slightly indicated. The strongly contractile polype, when extended,



Text-fig A. The occurrence of *Coryne Loveni* in the Northern Atlantic (the hatched coastal Region denotes a scattered occurrence, the totally black parts indicate a common occurrence)

attains to a length of nearly 2 mm., and then is slenderly fusiform or nearly cylindric; when contracted it is oviform, oval, or almost globular. The numerous capitate tentacles are irregularly distributed all over the polype.

The gonophores develop into eumedusoids, 1.5 mm. long, with no tentacles, normally not breaking away; they have four well-developed radial canals and a circular canal. Up to three gonophores occur on the polype near its base".

Material:

Greenland, Godthaab

litoral (on *Ascophyllum*)

Norway, Bjarköi, Lofoten

litoral (on *Fucoideae*)

Hartlaub (1907) informs us that in his aquaria he has observed a *Syncoryne*, whose gonophores are not set free, though being full-grown medusae with four tentacles well developed; the generative products are developed in the sessile medusa, which is reduced after having performed her generative task. Hartlaub refers this form to *Coryne* (*Syncoryne*) *Loveni* M. Sars. This identification however, cannot be right; most likely we have here rather in hand individuals of the *Coryne Sarsii* during the part of the generative period when the medusae are not detached. Through Mr. C. Dons, conservator at Tromsø, I received a very copious material of *Coryne Loveni* from Bjarköi, where the species occurs in abundance on the *Fucoidea* in the tidal water region. The large number of individuals examined have most frequently two, more rarely three gonophores, which are developed into a complete medusa without any tentacles. The four radial canals end in a small enlargement, which is the only indication of tentacles traceable. The species, accordingly, cannot be identical with the form recorded by Hartlaub, but agrees very well with the description and the illustration given by Lovén.

Coryne Loveni is earlier known only from the west coast of Scandinavia¹. Jäderholm (1909, taf. 1, fig. 7) gives an excellent drawing of the species collected from Bohuslän; elsewhere it is recorded from the coast of Norway from Bergen as far as Lofoten, where its occurrence in the northern part of its habitat is most numerous. Some colonies from Godthaab show us that *Coryne Loveni* must also be added to the fauna of Greenland. The species is native to the boreal tidal water zone and attains to its most luxuriant development in the passage to the regions of the Arctic Ocean.

Coryne pusilla Gärtner.

1774 *Coryne pusilla*, Gärtner, in Pallas: Spicilegia zoologica vol. 1, fasc. 10, pag. 40; pl. 4, fig. 8.

1893 *Syncoryne mirabilis* Levinsen, Meduser, Ctenophorer og Hydroider fra Grönlands Vestkyst, p. 150.

1902 *Coryne vermicularis*, *C. fruticosa*, *Syncoryne eximia*, Sæmundsson, Bidrag til Kundskaben om de islandske Hydroider, p. 50.

"The colonies are coarsely constructed, attaining a height of up to 40 mm. The hydrocaulus is wholly irregularly branched, showing no distinct main stem; the irregularly curved branches are everywhere densely wrinkled and form almost right angles with the hydrocaulus or with the mother branch. The strongly contractile polyp, when extended, attains to a length of 2.5 mm., and is then slender and narrowly fusiform or almost wholly cylindrical; when contracted, it is oviform or oval. The numerous capitate tentacles are irregularly distributed over the polyp.

The gonophores are globose, showing a styloid structure. There occur 4—8 gonophores, irregularly distributed over the proximal (basal) half of the polyp".

Material:

The Faroe Islands.

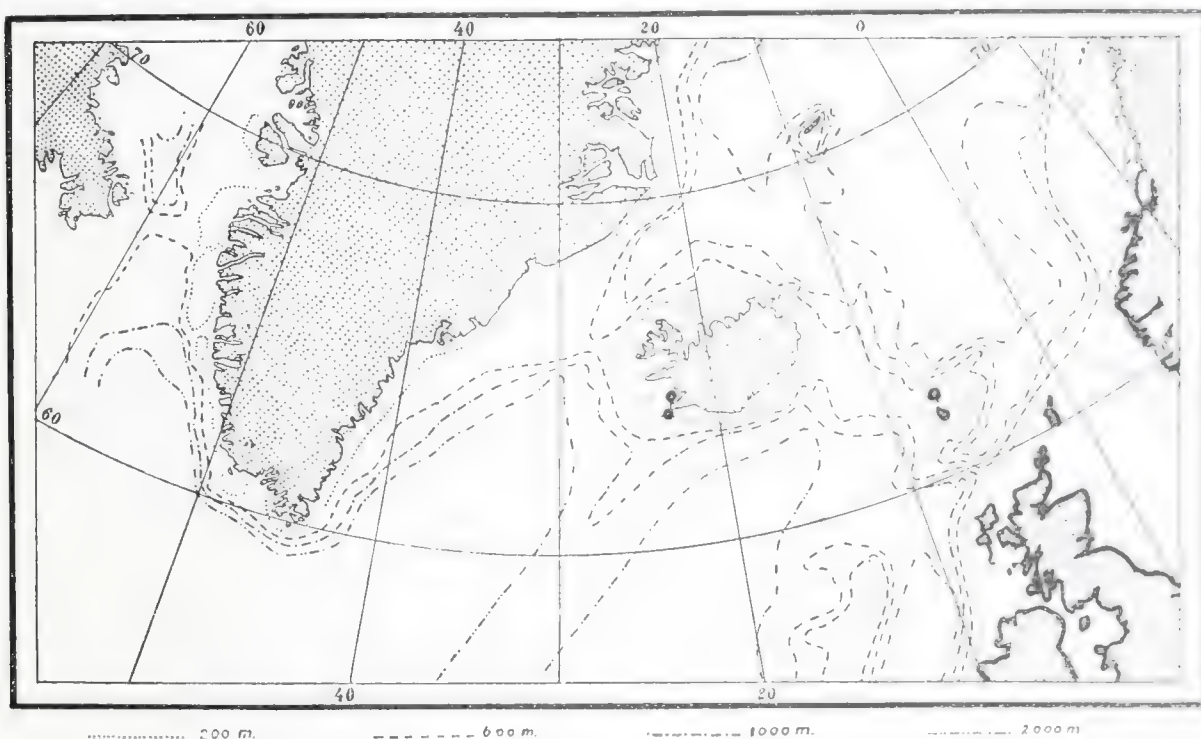
Iceland: Grindavik. On littoral algae (labelled *Coryne pusilla* and *C. fruticosa*).

Reykjavik. On littoral algae (labelled *Syncoryne eximia* and *Coryne vermicularis*).

Greenland (labelled *Syncoryne mirabilis*).

¹ Dr. P. L. Kramp kindly informs me, that *Coryne Loveni* is abundant in the Little Belt.

A closer investigation of the living polyps and of their conditions very soon shows us that the appearance of the polyp is varying very strongly according to its state of contraction. Now it is stretched at length, assuming approximately the shape of a thin worm, now it is again contracted to a short, thick lump, very nearly approaching the globular shape. Sometimes the polyp is at the widest at the base; sometimes it is contracted in this part, so that the largest width appears farther out. The study of the live polyps thus, in this case as in many others, shows us that many characters which have been turned to account as criteria of species with the Coelenterata, may be of most doubtful value or even of no importance whatever to classification. In the first place, of course, this is applicable to the various states of contraction, which, in *Coryne pusilla*, have even led to subdivision into several species. Jäderholm (1909) thus, on account of difference of shape of the polyp, still distinguishes *Coryne pusilla* and *Coryne vermicularis* Hincks; as, however, all other characters wholly



Text-fig. B. The distribution of *Coryne pusilla* in the Northern Atlantic.

agree, and the differences put to account as specific characters fall far within the limits of the polyp movements described above from observation of living individuals, the separation into species cannot be recognized; *Coryne vermicularis* forms a synonym of *Coryne pusilla* and, in fact, only represents a phase of the movement of the polyps.

Coryne pusilla has previously been recorded from the north of France, from Great Britain, Ireland, from Helgoland, from Denmark, from Bohuslän, from the west coast of Norway, from the Faroe Islands, and from Iceland (Reykjavik). In my material there also occurs a colony marked "Greenland?", wrongly determined as *Syncoryne mirabilis* Agass; the species thus seems to belong to the fauna of Greenland, but particulars are still missing. The rather numerous Icelandic colonies of the species are all derived from the south-western point of the island. The species, accordingly, must

be characterized as southern boreal; it mainly occurs along the coasts of the North Sea and round the British Isles; how far it advances to the north on the coast of Norway, we do not as yet know with certainty; but at any rate it does not push forward as far as into the Arctic seas.

***Coryne* sp. aff. *Hincksi* Bonnevie.**

Material:

"Ingolf" St. 44. 61°42' Lat. N., 9°36' Long. W., 545 met. 48°.

A small colony of young individuals of a species of *Coryne* is attached to the stalk of a *Tubularia* sp. The hydrocaulus is irregularly wrinkled and attains a height of up to 6 mm. with polyps 1—2 mm. long. There occur 4—8 small, apparently medusoid, gonophores at the base of the polyp closely below the tentacles. The tentacles are short. The stolon of the colony is reptant, the stalks of the polyp are unbranched. On account of the bad state of preservation it is impossible to furnish a proper design of the individuals.

It is possible that the individuals belong to the species *Coryne Hincksi* Bonnevie, which has previously been recorded only from a depth of 100 fathoms near Hammerfest (Bonnevie 1899).

Family Myriothelidae.

"Large solitary hydroid polyps with stratified ectoderm, in which occur two kinds of nematocysts. Besides the typical oviform nematocysts of *Capitata* are found in somewhat smaller numbers narrowly oval or nearly cylindrical, rather large nematocysts which are especially frequently occurring in the ectoderm of the gonophores. The tentacles are capitate with a central cavity which does not communicate with the gastral cavity of the polyp, and which is distally broader. The vigorously developed distal portion of the tentacles is shored up by a particularly developed portion of the supporting lamella, here showing a fibrillary structure with fibres radiarily arranged. The supporting lamella is vigorously developed in the wall of the polyp and provided with bilamellae. The endoderm exhibits a dense circle of mucous glands at the mouth of the animal. No calcareous skeleton is developed".

The *Myriothelidae* seem to be nearly related to the *Corynidae*, and also to the *Milleporidae*, which latter form calcareous skeletons. The last mentioned family presents in its dimorphically developed nematocysts a strong resemblance to the *Myriothelidae*. However, only a character as the peculiarly developed supporting lamella in the thickened distal portion of the tentacles, as well as the dimorphic development of the nematocysts, justifies the distinction of the *Myriothelidae* as a particular family beside the *Corynidae*. Already Bonnevie (1899) has pointed out the near relation between *Myriothelidae* and *Corynidae* and the bridge between them suggested by the species *Monocoryne gigantea* (Bonnevie). The arrangement by groups of the tentacles and the attachment of the gonophores to these groups are very likely to form the base of the development of the blastostyles of *Myriothela*. But on account of the peculiar direction in which the structure of the tentacles

of the *Myriothelidae* has developed, we cannot subscribe to the view of Kühn (1913), reducing the two families into one. The anatomical structure of the polyps of the two groups differs too much, and to this difference must be attached a greater importance than the investigators have hitherto been inclined to do; anatomically the difference between the groups is too great to allow their amalgamation, in spite of the agreement of the two families as to the endodermal mucous gland portion near the orifice of the polyp.

Hitherto only one genus has been recorded of *Myriothelidae*.

Gen. *Myriothela* M. Sars.

"The large solitary polyps have only exceptionally slight indications of hydrocaulus; in general the base of the polyp is truncate or pointed and provided with rhizoids or filaments of adhesion, which are in fact transformed tentacles. Both the ectoderm and the endoderm are stratified. The tentacles are capitate and are irregularly distributed over the polyp and the blastostyles. The gonophores are developed on small polyp-like blastostyles attached to the inferior half of the polyp; the blastostyles bear tentacles on their distal portion".

The genus *Myriothela* is recorded from the northern seas and from the Antarctic Ocean. The spread and rare occurrence of the individuals prevents us from deciding whether the genus is in fact bipolar, as the finds hitherto recorded seem to indicate.

Myriothela phrygia (Fabricius) M. Sars.

1780 *Lucernaria phrygia* Fabricius, Fauna Groenlandica, Nr. 333, p. 343.

1851 *Myriothela arctica* M. Sars, Beretning om en zoologisk Reise, p. 134.

1873 — *phrygia* G. O. Sars, Bidrag til Kundskab om Norges Hydroider, p. 130.

"The capitate or almost cylindrical polyp extended reaches a length of about 400 mm. The inferior termination of the polyp is truncate, and it is attached to the substratum by tentacle-like filaments of adhesion. Above the portion wearing blastostyles it is studded with strong capitate tentacles; on the other hand tentacles are wanting on the surface of the polyp between the blastostyles.

The cryptomedusoid gonophores are developed on small polyp-like blastostyles, attached to the inferior portion of the polyp and wearing capitate tentacles on their outward parts. The female blastostyle has only one or two fully-developed gonophores at the same time, while the male blastostyles wear numerous gonophores".

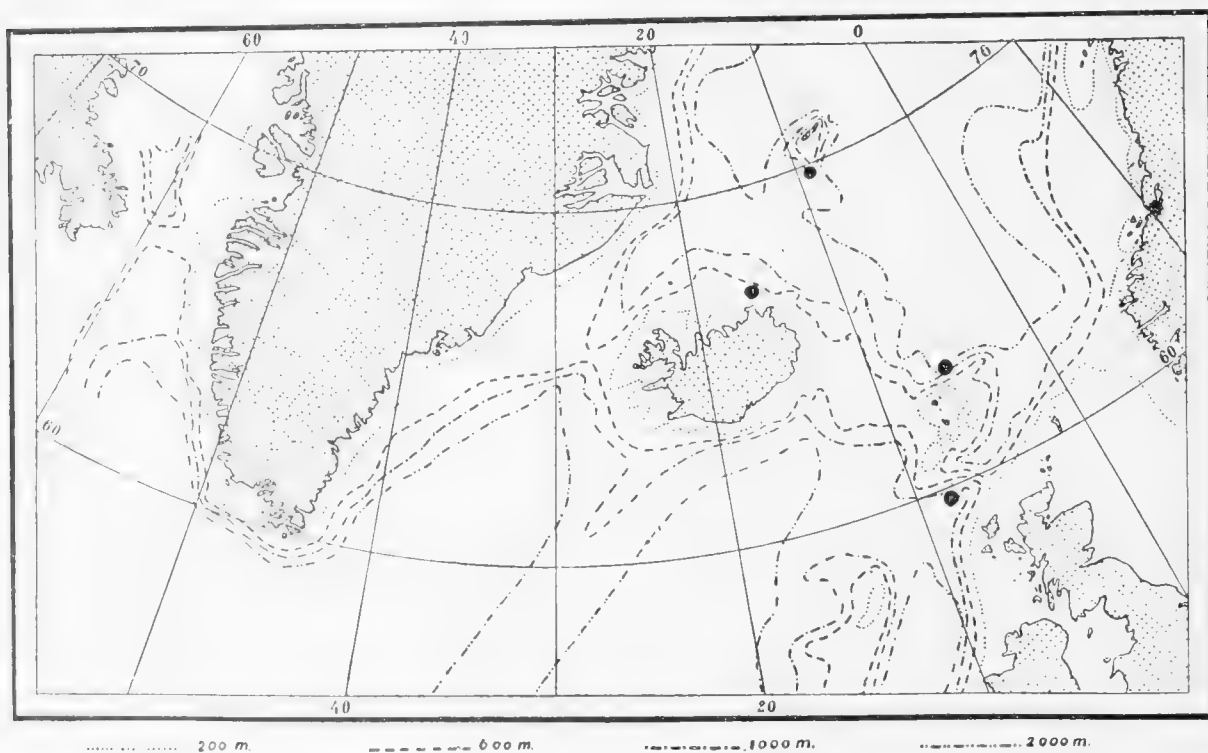
Material:

"Ingolf" St. 117. 69°13' N., 8°23' W., depth 1003 fathoms, ÷ 1° C.

— St. 125. 68°08' N., 16°08' W., — 729 — ÷ 0.8° C.

Myriothela phrygia has an enormous faculty for extension and contraction, and it is likely to share this faculty with its nearest relatives. A specimen I had the opportunity of observing when it was brought up by the trawl in the Trondhjemfjord, had stretched its distal portion wearing tentacles so strongly that the animal was as thin as a thread and measured up to 30 cm. in length; but as

soon as it was irritated by the preservation fluid, it contracted to a length of only 9 cm., and simultaneously the diameter of the distal portion of the polyp increased to the measure of 2–3 mm. This observation shows how little importance is, in fact, to be attached to the absolute measures of the polyp in the limitation of the species of *Myriothela*. While the individuals from st. 117 wholly agree with the earlier descriptions and drawings of the species, the defective specimen from st. 125 (tab. I, fig. 8) at the first glance differs greatly. The broad, longitudinally strongly contracted basal portion is studded with blastostyles in a narrow belt, above which the polyp tapers rapidly so as to assume a conical appearance fairly reminding of the drawing by Bonnevie of *Myriothela mitra* (1899, tab. IV, fig. 3). However, a closer examination shows that the distal portion of the polyp has been torn off,



Text-fig. C. Localities of *Myriothela phrygia* in the Northern Atlantic.

and as its trunk above the blastostyles is studded with capitate tentacles, while the polyps of the species mentioned have no tentacles at all, a mistake of identity is out of the question.

Myriothela phrygia is an arctic deep-sea form, mainly occurring in the icy water at the bottom of the northern seas. It is recorded from Taimyr (Jäderholm 1908), from the north of Norway, and from the depths of the ocean between Spitzbergen and Greenland (Bonnevie 1899), besides from the localities laid down in the map subjoined (Text-fig. C). The original description has been given on specimens from Greenland, from where, however, we still lack particulars as to localities. "Ingolf" now adds two new finds in the waters of the Arctic Sea between Iceland and Jan Mayen. On the whole, the occurrence of the species is scattered; most of the finds are situated in high-arctic regions, and here the species is seen to occur even at so small a depth as between 128 and 146 m (Jäderholm 1908). Therefore, two localities are, indeed, apt to give surprise. One of these localities is recorded

from the "Michael Sars" 1902, when the species was found in the warm Atlantic waters to the south of the Wyville-Thomson-Ridge (Broch 1903). There is in this case a possibility that the animal has been carried with Arctic currents from northern regions; if so, the currents have conveyed the animal at an early period of life to the new locality, where it has been able to subsist and develop further. The other locality, in the Trondhjemfjord was previously recorded, and the Trondhjem Museum was in possession of a defective specimen which was said to have been taken in the fjord; but particulars were wanting till the researches of the fjord in 1911 brought to light, from the depth of 200 m., near Tautra, and thus in the midst of the Atlantic water layers of the fjord, a well developed female polyp. This find gives the more surprise, because there is left no opening for the possibility that the specimen should have been carried to this place from Arctic water layers. Like other Arctic hydroids, such as *Tubularia regalis* Boeck, *Corymorpha groenlandica* (Allman), and *Stegopoma plicatile* (G. O. Sars), *Myriothele phrygia* thus thrives very well in the region of the Trondhjemfjord which is otherwise characterized by Atlantic *Lophohelia*-reefs. This cannot, however, be turned to account as a proof against the Arctic character of the species; in the Trondhjemfjord all these species must be looked on as Arctic relicts.

Family Tubulariidae.

"Hydroids forming colonies, or solitary, with large oviform or globose nematocysts in the ectoderm. The tentacles of the full-grown polyp are filiform and simply constructed with no central cavity; they are arranged in two main circles, a proximal whorl round the broad basal portion of the polyp and a distal whorl round the mouth. The basal whorl of tentacles is supported by a ring-shaped mesogloal cushion round the basal portion of the polyp. The polyps are radially symmetrical. The supporting lamella shows a very simple structure".

Most authors refer to this family also *Branchiocerianthus*, which I reckon as the type of a family of its own, the *Branchioceranthidae*. This family is distinguished from the *Tubulariidae* partly by bilaterally symmetrical polyps, partly by the peculiar anatomical structure of the polyps. In fact, the structure of the polyps of the *Branchioceranthidae* differs greatly from that of all other hydroids (comp. Stechow 1909). There occurs a supporting lamella of complicated structure, and the polyp is provided with numerous, prominent radial canals. They are distinguished from the *Tubulariidae* also in their inner anatomy by almost lacking any trace of mesogloal tissue at the base of the proximal whorl of tentacles, owing to the radial canals. These points of difference are, indeed, of such importance that they fully justify the separation of *Branchiocerianthus* into a family of its own, the *Branchioceranthidae* beside the *Tubulariidae*.

Kühn (1913) divides the *Tubulariidae* into two subfamilies, *Tubulariinae* and *Corymorphinae*. The former he defines by the characters "Koloniebildend, Periderm gut entwickelt", while the latter is defined as "Solitär, Periderm häutig oder rückgebildet, Wurzelhaare". To this is to be observed that a species as *Tubularia cornucopia* Bonnevie is a typical *Tubularia* in spite of its forming no colonies. The filamentary appendages of *Corymorpha* must be compared with similar phenomena in *Myriothele*, some species of which have rhizoids, while others such as *Myriothele Cocksii* (Vigurs), attach themselves by a plateformed perisarc; when this is considered as nothing else or no more than a criterion

of species with *Myriothele*, there tells indeed little in favour of raising it to a distinguishing mark between two subfamilies of the *Tubulariidae*. As far as finally the development of the periderm is concerned, this is a gradual character showing many transitions, to which no importance can be attached as a distinguishing mark between two subfamilies.

Gen. *Tubularia* Linné.

"Hydroids most frequently forming colonies, the hydrocaulus being surrounded by a stiff and chitinous perisarc. The polyps are radially symmetrical, having two main circles of tentacles, a proximal (basal) whorl of long tentacles leaning on a mesogloecal ring in the trunk of the polyp, and a distal whorl with short tentacles round the mouth. The tentacles are also in the actinula filiform.¹ The gonophores are generally borne on blastostyles; the gonangia spring from the trunk of the polyp between the two whorls of the tentacles".

The gonophores are, in this genus as in most other genera, sometimes medusoid, sometimes more or less reduced. The species producing free medusae have been grouped by many authors as a genus of their own, *Hybocodon*. In this case as in others, the question then arises where the line is to be drawn. While in species as *Tubularia pulcher* (Sæmundsson) the medusa breaks away, the fully developed medusoid gonophore in *Tubularia regalis* Boeck, as far as is known to us, never voluntarily relinquishes its sessile existence. If we follow Kühn (1913), as might seem right, we get into a dilemma, having to refer the female of *Tubularia regalis* to *Hybocodon*, while the male, having cryptomedusoid gonophores (Broch 1915), must remain in the genus *Tubularia*. Only this should be sufficient to show the error of turning the organisation of the gonophores to account as fundamentum divisionis. No doubt, it is wrong to set up *Hybocodon* as a particular genus of hydroids, and the same is certainly the case with the genus *Auliscus* set up by Sæmundsson (1899), the medusae of which as we are going to see, are scarcely particularly distinguished as compared to the other *Hybocodon*-medusae.

Tubularia pulcher (Sæmundsson).

1899 *Auliscus pulcher* Sæmundsson, Zoologiske Meddelelser fra Island, p. 425, Tab. IV.

"Colonies, the hydrocauli of which are up to 50 mm. long, unbranched, and separated down to the reptant hydrorhiza. The stalk is covered with a brown perisarc, which is thick at the base, but upwards against the polyp narrowing periodically and at distinct intervals, so that the stalk gets an appearance approximately articulate; the spaces between the transverse striae, brought about in this way, attain their greatest length in the middle part of the stalk, being here 13 mm. long. The upper portion of the stalk is provided with a thin perisarc, widening funnel-shapedly into a thin collar under the polyp. The polyp is fitted out with a basal circle of 24—30 tentacles, about 5 mm. long; the distal tentacles, about 30, are placed, densely crowded, in a narrow belt, consisting of several rows, round the orifice, and attain a length of a little more than 1 mm.

The gonophores develop into free *Hybocodon*-medusae with gemmation on the bulb of the

¹ The tentacles of the actinula may be swollen at their tips (comp. Allman 1872) but never show the dense accumulation of stinging cells here, which is so characteristic in the truly capitate tentacles of the section *Capitata*.

large tentacle; there are four radial canals. The bell exhibits five exumbrellary stinging cell stripes. The gonophores are developed on eight blastostyles faintly branched, a little more than 1 mm. long".

Material:

Iceland, Reykjavik. Near the shore (1 specimen).

The specimen in hand is one of the original specimens investigated by Sæmundsson (1899). It is an individual with hydrocaulus 30 mm. high. The polyp is fitted out with 25 proximal tentacles, 5 mm. long, and 8 blastostyles a little branched, about 1 mm. long. A closer inquiry of the gonophores gives a picture somewhat different from that drawn from the explanation of Sæmundsson. In the first place the umbrella of the medusa is not quite symmetrical, but somewhat oblique, as in *Hybocodon prolifer* L. Agassiz. At first only one tentacle, not two, is developed on the large tentacle bulb (Tab. II, fig. 16); the "corpora acuminata et duo ovata", mentioned by Sæmundsson as springing from the tentacle bulb, are all gems of medusae; none of them can be made out as "initium tentaculorum novorum" belonging to the original medusa. Wherever at the first glance two tentacles seem to occur on the bulb, a closer research will show that one of them in fact belongs to the bud of a new medusa on the bulb of the gonophore. Therefore, we have to concur in the opinion of Hartlaub (1907) and subscribe to his explanation of the apparent occurrence of two tentacles with *Hybocodon prolifer* as satisfactory for the species in hand, that "bei der Knospung von *Hybocodon* der Tentakel in der Entwicklung stark voraneilt und schon fertig sein kann, wenn der dazu gehörige Medusenkörper noch nicht deutlich in die Erscheinung getreten ist".

The conditions of gonophores described show a much nearer relationship to *Tubularia* (*Hybocodon*) *Christinae* Hartlaub (= *Tubularia prolifer* Bonnevie 1899). Hartlaub's drawing of *Hybocodon Christinae* (1907, fig. 98) is, according to the statements cited, easily reconcilable to the figure a little more skeletonlike given by Sæmundsson (1899, tab. IV, fig. 3). Nor is the difference between the polyps very great; Bonnevie (1899) states for her specimen 14 proximal tentacles, about 10 mm. long, while the species stated by Sæmundsson is said to have 24—30. It is a matter of regret that we only know the length of the proximal tentacles of the specimen in hand. But on account of the great contractility of the tentacles, no particular systematical importance can be attached to their length, and as far as the difference of numbers of the proximal tentacles is concerned, we see in other *Tubulariidae* within easy reach such a variety that the difference quoted by itself cannot justify any separation of species. When *Tubularia Christinae* is nevertheless maintained as a separate species beside *Tubularia pulcher*, it is in the first place owing to the express declaration of Bonnevie (1899) that her specimen has no collar under the hydranth; such a collar is, on the other hand, strongly developed in *Tubularia pulcher*, though at the first glance it may seem very little distinctive on material preserved.¹

Hartlaub (1907) holds that the medusa is identical with the medusa drawn by Steenstrup (1842), *Coryne fritillaria*, and much is speaking in favour of the correctness of this supposition. On the other hand, the polyp described by Steenstrup, in the same place and by the same name, cannot be identified. It may be that it really is a *Coryne*; some features are even suggestive of *Coryne Loveni* M. Sars; but the only thing the drawing shows us with full certainty, is that the polyp is no

¹ The original specimen of Bonnevie's *Tubularia prolifer* was wanting in the museum of the Kristiania university

Tubularia, and that its medusoid gonophores, if they are rightly perceived, cannot develop into medusae of the *Hybocodon* type.

The only locality from which *Tubularia pulcher* is recorded with certainty, is the shore near Reykjavik, Iceland, where it has been found only once.

Tubularia indivisa Linné.

1758 *Tubularia indivisa* Linné, Systema Naturae, Ed. 10, p. 803.

1899 — *obliqua* + *T. indivisa* Bonnevie, Norske Nordhavs-Expedition, p. 24.

"Colonies, whose long dark brown-coloured hydrocauli are, in the lower part, twisted together. The stems are covered with a vigorous perisarc, but show no rings nor wrinkles. No collar is formed below the polyp. The polyp has a basal whorl of 20 to 30 tentacles up to 20 mm. long; the distal tentacles are up to 3 mm. long and densely crowded round the orifice in a whorl consisting of several rows.

The female gonophores are eumedusoid with four rudimentary radial canals, one of which (the shortest) is often slightly indicated even in the gonophore fully developed. The gonophore has, near the apex, a tentacle-like bulging, obliquely situated. The male gonophores are cryptomedusoid and almost wholly globular, not oval. The gonophores are born upon up to 10 blastostyles, which attain a length of 10 mm. The actinula-larvae, when set free, wear filiform tentacles".

Material:

"Ingolf" St. 31, 66°35' N., 55°54' W.; depth 88 metres 1.6° C. (Davis's Straits).

— St. 87, 65°02' N., 23°56' W.; depth 110 metres (West-Iceland).

Greenland: Davis's Strait (without further data).

— Egede's Minde (— — —).

Iceland: Brede Bugt 65°12' N., 23°28' W., depth 36 fathoms.

— Grindavik littoral.

— Skagestrand depth 60 fathoms.

— Vestmannaö littoral.

The Faroe Islands (without further data).

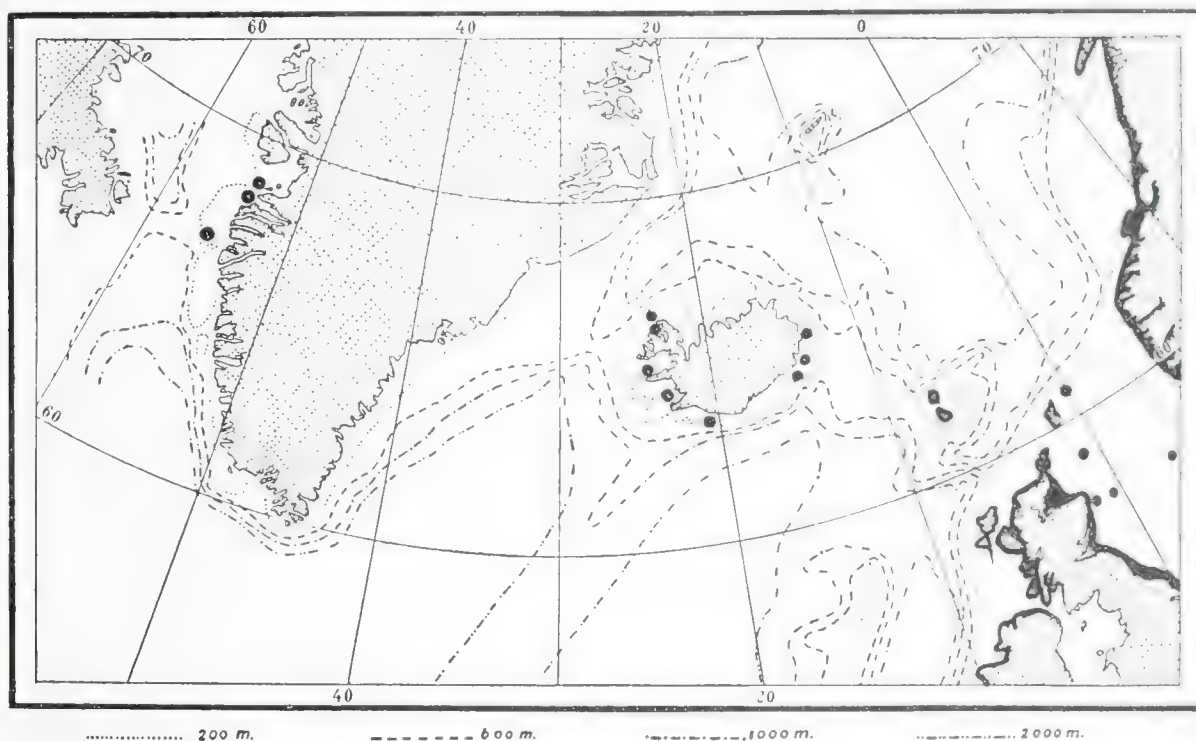
The North Sea: the West side of large Fishing bank 57°7' N., 2°40' E., depth 37 fathoms.

Swenander (1903) has pointed out that *Tubularia obliqua* Bonnevie (1899) is based on female individuals of *Tubularia indivisa*; thus in the very external characters of the gonophores this species presents a peculiar sexual dimorphism, and inquiries into the conditions of the gonophores (Broch 1915) have made good that this sexual dimorphism is a radical one, the female gonophores being eumedusoid, the male ones on the contrary cryptomedusoid. — *Tubularia indivisa* is very easily confounded with the following species, *Tubularia regalis*, particularly when only male individuals are in hand for examination. In this case only the somewhat different shape of the gonophores makes it possible to refer with certainty the individuals to one species or the other, the male gonophore of

Tubularia indivisa being globular, and accordingly broadly rounded in the distal part, while that of *Tubularia regalis* is oval and showing an attempt to be pointed in the distal part.

Tubularia indivisa has a very wide distribution. Its main occurrence in the boreal seas is bound to the middle and deeper parts of the littoral region and to the upper part of the deep sea region. From the cold area we find the species but once recorded, by Grieg (1914). After the examination of his specimens I cannot confirm this record; the specimens consisting only of hydrocauli without polyps, more probably belong to another species of *Tubularia* inhabiting the deep sea.

To judge from literature, *Tubularia indivisa* penetrates rather far into the shallower parts of the Arctic regions, where it is recorded even from the New Siberia Islands (Jäderholm 1908). However, as appears from what is stated above, there is a possibility that some of the Arctic individuals



Text-fig. D. The distribution of *Tubularia indivisa* in the Northern Atlantic.

are in fact to be referred to *Tubularia regalis*. — The species also penetrates far towards the south. It is recorded by Fewkes (1881) even from the Caribbean Sea, by Allman (1877) from between Cuba and Florida, and by Billard (1906) from the west coast of Africa. As *Tubularia indivisa* is recorded at the same time both from the East and the West coast of North America, it must be characterized as a circumpolar or rather "circumboreal" (Nordgaard 1912) species.

Tubularia regalis Boeck.

1860 *Tubularia regalis* Boeck, Videnskabselskabets Forhandlinger for 1859.

1899 — — + *T. variabilis* Bonnevie, Norske Nordhavs-Expedition, p. 24.

Colonies whose long, dark-brown-coloured hydrocauli are in the lower parts twisted together. The stem is covered with a vigorous periderm, but shows no rings nor wrinkles. No collar is formed

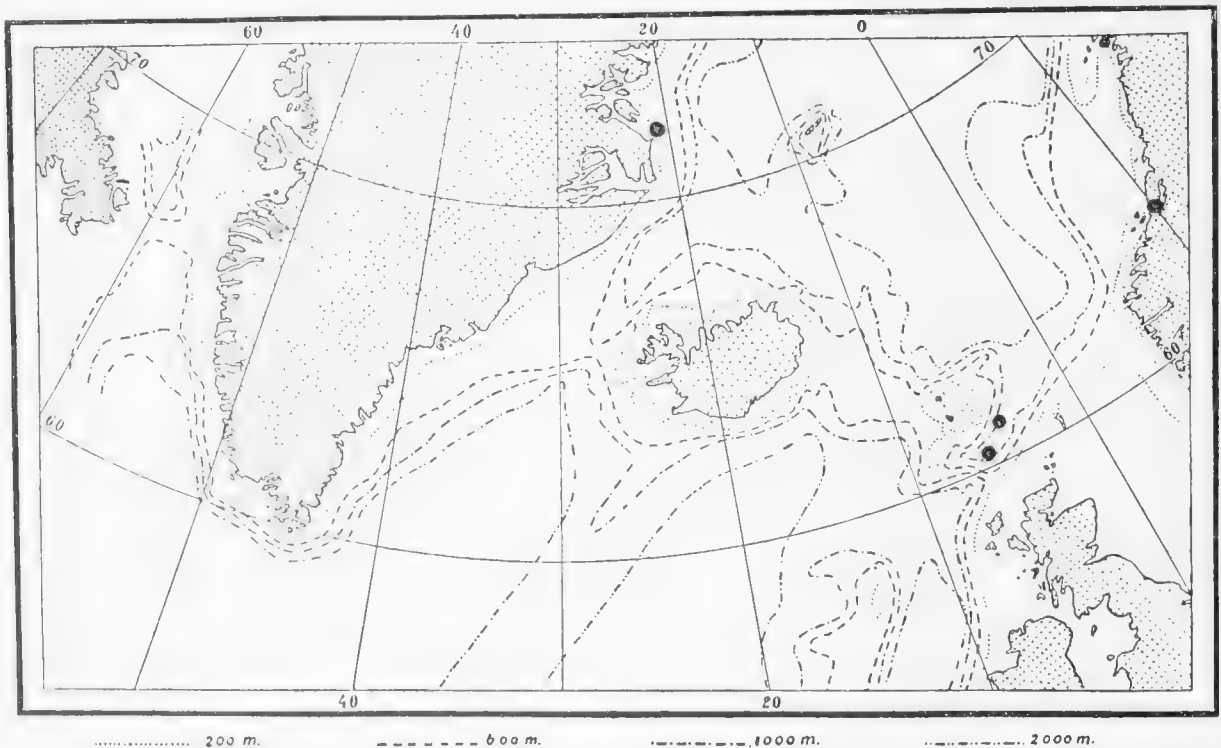
below the polyp. The polyp wears a basal whorl of 20–35 tentacles up to 40 mm. long; the distal tentacles, up to 3 mm. long, are densely crowded round the orifice in a whorl consisting of several rows.

The female gonophores are eumedusoid with 3–6 external longitudinal ribs and as many corresponding radial canals. The male gonophores are cryptomedusoid and oval, often with an attempt to be pointed in the distal part. The gonophores are born upon up to 20 blastostyles, which attain a length of 35 mm. The actinula larvae, when deliberated, wear filiform tentacles.

Material:

Between the Faroe Islands and the Shetlands, depth 505 fathoms.

Tubularia regalis presents so many points of resemblance to *Tubularia indivisa* that the risk of confounding the two species is very easily incurred. As a general rule, the full-grown polyps of *Tu-*



Text-fig. E. The occurrence of *Tubularia regalis* in the Northern Atlantic.

bularia regalis are larger than those of *Tubularia indivisa*. But this is not the case in younger individuals of *Tubularia regalis*, in which consequently the only certain distinguishing marks are presented by the gonophores. The gonophores, indeed, are typical enough in the female individuals, but are not very conspicuous in the male ones, especially at earlier stages. The male gonophores of *Tubularia regalis* are oval, while those of *Tubularia indivisa* are globular. It is evident from the diagnosis of the species, that also *Tubularia regalis* presents a strong sexual dimorphism. The first who got aware of this fact, was Swenander (1903), who accordingly pointed out that the female had been described as a different species *Tubularia variabilis* Bonnevie.

Tubularia regalis is a form of true Arctic character, particularly occurring in the deeper parts of the cold area. In the seas far towards the north it rises to shallower parts, and it is, for instance,

recorded from Spitzbergen at the depth of only 38 m. (Broch 1909). Evidence of its occurrence in the Kara Sea is still wanting. From this locality a specimen is in hand, determined by Bergh (1887) as *Tubularia regalis*. As a matter of fact, the specimen is a *Corymorpha*, probably a *Corymorpha glacialis* M. Sars. — A remarkable exception to the habitat stated is formed by the frequent occurrence of the species in the Trondhjem Fjord, where it is found in abundance on the *Lophohelia*-reefs. In spite of the luxuriant development which it attains in the Trondhjem Fjord, it must probably, like *Corymorpha groenlandica* (Allman), *Myriothele phrygia* (Fabricius), and *Stegopoma plicatile* (G. O. Sars), be accounted for as an arctic relict in this locality.

Tubularia larynx Ellis et Solander.

1786 *Tubularia larynx*, Ellis et Solander, The Natural History of Many Curious and Uncommon Zoophytes, p. 31.

1864 — *humilis*, Allman, Notes on Hydroida, p. 57 and 60.

Colonies whose long polyp stems, generally unbranched and irregularly curved, are separated quite down to the tangled network of basal tubes. The stems are covered with a fairly vigorous, but colourless perisarc, which is irregularly wrinkled or more rarely quite smooth. The polyp wears a basal whorl of up to 25 tentacles, attaining a length of 8 mm.; the numerous distal tentacles, 2 or 3 mm. long, are densely crowded round the orifice in a whorl consisting of several rows.

The gonophores are eumedusoid, without radial canals, but with a rudimentary circular canal; they are most frequently provided with three rudimentary tentacles. The gonophores are supported by 6—12 short blastostyles, which may be erect or hanging. The actinula larvae, when deliberated, show filiform tentacles.

Material:

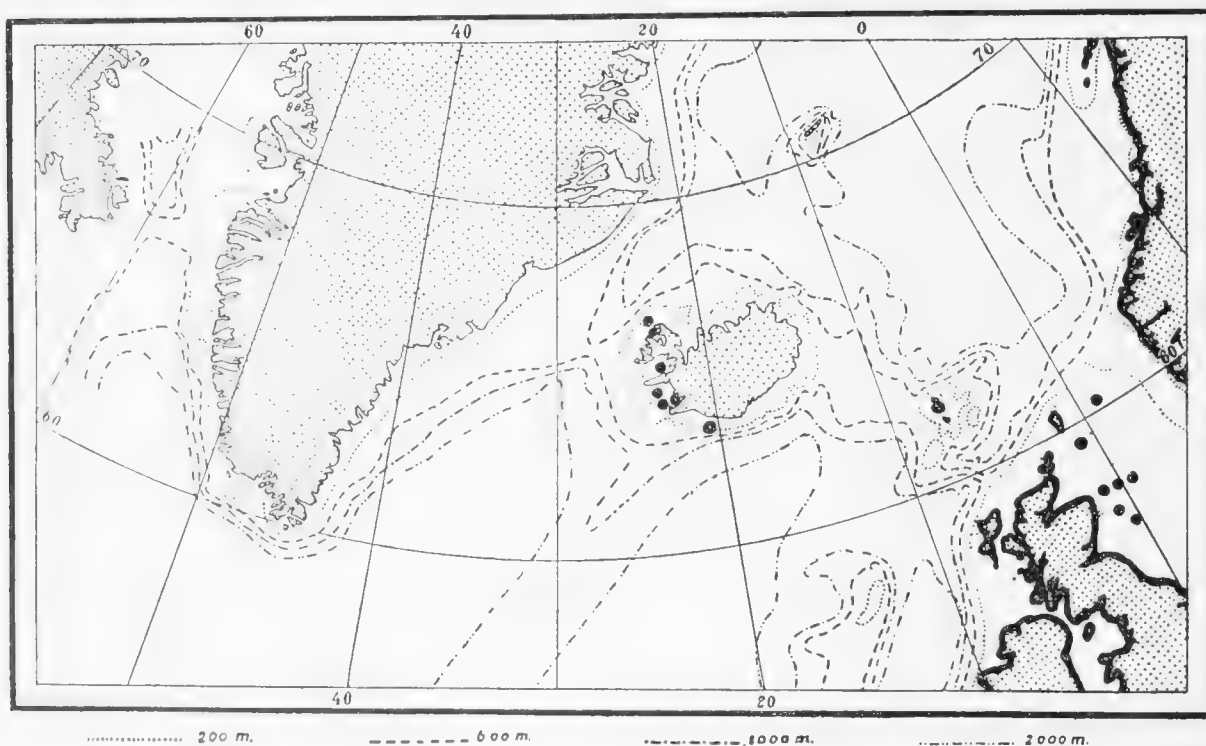
Iceland: Reykjavik.

	depth	1	1ath
Gustsey	—	15—16	—
Keflavik	—	19.5	—
Faxebugt three miles N 37 E Keflavik	—	25	
Off Havnefjord	—	20	3
Stykkisholm	—	40	m.
Skagi	—	2	100
Vestman Islands	—	16—23	
The Faroe Islands: Andefjord	—	50	—
The North Sea 60°35' N., 1°50' W.	—		

The synonymy of the varying species has been thoroughly accounted for by Fenchel (1905). He points out that, as is also maintained by Bonnevie (1899) and by Swenander (1903), *Tubularia coronata* Abildgaard must be subsumed under *Tubularia larynx*. On the other hand, it is not plainly seen whether he regards *Tubularia humilis* Allman to be a peculiar species. On a closer examination, indeed, the characters pointed out by Bonnevie (1899) as distinguishing marks, prove to be of no particular systematic importance. The wrinkling of the stem is strongly varying from

one individual to another in a larger colony, and individuals with quite smooth stems are not seldom observed in colonies which are otherwise typical *Tubularia larynx*. The dimensions of *Tubularia humilis* wholly agree with those of young colonies of *Tubularia larynx*, and the numbers stated as characteristics stand far within the range of variability known in this species. Then only remains the condition of the blastostyles, which should be erect in *Tubularia humilis*, but hanging in *Tubularia larynx*. An examination, however, of living material will show that only in rare cases the blastostyles of *Tubularia larynx* can be described as hanging (comp. Broch 1911); on the contrary they are generally borne in a rather erect position, particularly when not yet very large. Thus also this criterion proves to fail, and consequently we are forced to consider *Tubularia humilis* as a synonyme of *Tubularia larynx*.

Tubularia larynx is an entirely boreal species, which has its main occurrence in the zone of the



Text-fig. F. The distribution of *Tubularia larynx* in the Northern Atlantic.

laminaria and the red algae. Towards the south it enters into the Mediterranean, and towards the north it penetrates as far as Nova Zembla, and seems still to occur at Spitzbergen. On the south-western coasts of Iceland it is very frequent, and it is also found on the east coast of North America. It is to be wondered that the species has not yet been met with at Greenland.

Tubularia sp. indet.

Stems of *Tubularia* of the type *indivisa-regalis* are in hand from the following localities:

"Ingolf" St.	8.	63°56' N.,	24°40' W.,	depth 136 fathoms,	+ 6°0 C.
—	-	35.	65°16' - 55°05'	- 362	- + 3°6 -
—	-	36.	61°50' - 56°21'	- 1435	- + 1°5 -

HYDROIDA

"Ingolf" St. 40.	62°00' N.,	21°36' W.,	depth 845 fathoms,	+ 3°3 C.
— - 86.	65°03'6 -	23°47'6 -	— 76	-- ?
— - 87.	65°03'2 -	23°56'2 -	— 110	— ?
— - 106.	65°34' -	8 54' -	— 447	: 0°0 C.
— - 127.	66°33' -	20°05' -	— 44	— + 5°6 -
— - 143.	62°58' -	7°09' -	-- 388	— ÷ 0°4 -

Of a type like that of *Tubularia cornucopia* Bonnevie from the localities:

"Ingolf" St. 11.	64°34' N.,	31°12' W.,	depth 1300 fathoms,	+ 1°6 C.
— - 18.	61°44' -	30°29' -	— 1135	— + 3°0 -

Gen. *Corymorpha* M. Sars.

Solitary hydroids, whose contractile hydrocaulus is surrounded by a flexible, thin, and membranaceous perisarc. The hydrocaulus is attached to the substratum by numerous rhizoids. The structure of the polyp is radially symmetrical with two main whorls of tentacles, a proximal or basal whorl of long tentacles supported by a mesogloea ring in the polyp body, and a distal whorl of short tentacles round the orifice. In the full-grown polyp all the tentacles are filiform; in the actinula larva at any rate the distal (oral) tentacles may be capitate. The gonophores are generally supported by blastostyles; the gonangia arise from the body of the polyp between the tentacle whorls.

As early as 1909 I stated this limitation of the genus, grouping at the same time the species, on the ground of gonophoral matters, in four subgenera. However, I suggested that, as to the relations between the two subgenera *Monocaulus* and *Lampra*, a closer inquiry was wanting. As a matter of fact, one of the species stated by Allman (1876) *Monocaulus groenlandica* really proves to be identical with two of the species of *Lampra* stated by Bonnevie (1899). Also the other northern species of *Monocaulus* has met a peculiar fate, being first ranked by Allman (1872) within his genus as *Monocaulus glacialis* (M. Sars), and afterwards (1876), after the examination of some specimens from the museum of Copenhagen, described as a new species, *Amalthaea islandica* Allman.

These matters, indeed, throw a glaring light on the unmaintainability of the subdivision into so-called "genera" to which *Corymorpha* has been the subject. At the first glance it is a matter of surprise that Stechow (1913) still tries to maintain the old genera. Indeed, in zoology more consideration must be given to the observations made on living individuals than has hitherto been done. Thus the two main criteria turned to account by Stechow (1912) for the purpose of distinguishing *Corymorpha Sarsii* Steenstrup (1854) and *Corymorpha vardöensis* Loman (1889) testify to the fact that matters of contraction are still allowed to play a prominent part as to the limitation of species. By the observation of a living *Corymorpha* it will soon be ascertained that, by extension and contraction of the lower parts of the polyp and of the upper sections of the stem, the same polyp will show now a more emphatic distinction from its stem, now a smoother transition into it. The points of difference delineated by Stechow (1912, Taf. 12, Fig. 2 and 3) are, in this respect, not so great as those which may be observed in a single individual while alive. The other main character, that the spadix of the

gonophore of *Corymorpha Sarsii* is "fast immer" projecting from the umbrellar cavity, while this is "fast nie" the case with *Corymorpha vardöensis*, is in the first place very vague, and secondly dependent partly on the various contraction of the umbrella, partly on the sex and the degree of maturity of the gonophore. On the whole there can be no doubt that the description of *Corymorpha vardöensis* is based on an individual of *Corymorpha Sarsii*.

I have entered on this subject because Stechow (1912, 1913) puts together the species mentioned into a genus of their own, *Amalthaca*. The genus was first established by O. Schmidt (1854) for the species *Amalthaca uvifera* O. Schmidt, which is likely to be identical with *Corymorpha Sarsii*. It embraces the species of *Corymorpha* whose gonophores develop into complete medusae, but, after all, not breaking away, whereas the species whose medusae are normally breaking away, are gathered in the genus more narrowly limited, *Corymorpha*. It is evident, however, that the medusa of *Amalthaca* exceptionally breaks away and then leads a wretched life, unfit as it is for free existence on account of possessing a too small umbrella, the greater part of which is, into the bargain, occupied by the enormous spadix with mature generative cells. The medusa strongly reduced, further, shows so near a relationship to the medusa of *Corymorpha nutans* M. Sars that a systematist of medusae so skilful and discerning as Hartlaub (1907) decides on only placing it in a subgenus of the medusoid genus *Corymorpha*. The classification afterwards maintained by Mayer (1910), who distinguishes the two groups of medusae as peculiar genera and even places them in quite different places in his synopsis, as *Amalthaca* and *Steenstrupia*, only proves that he has failed to notice the excellent drawing by M. Sars (1877), which shows us in fact, that the female gonophore, when fully developed, is often an entirely typical *Steenstrupia*, though one of the main tentacles is not quite so large as in *Corymorpha nutans*. The figures delineated by Sars wholly agree with the facts observed in living individuals, and make good the correctness of Hartlaub's view of division, giving the right place to affinity and biology. But where is then the fundamentum divisionis adaptable for the purpose of classifying the *Corymorpha*-like species of polyps into separate genera?

From *Amalthaca* to *Monocaulus glacialis* there is, indeed, a very short step; all the difference, as a matter of fact, is to be found in the gonophore, also here eumedusoid, being even somewhat more reduced, as the tentacles, the special organs of the umbrellar margin, are entirely wanting. The conformity of the polyps is obvious; the gonophores of both species are eumedusoid and normally sessile; the difference is accordingly too little for a separation of genera.

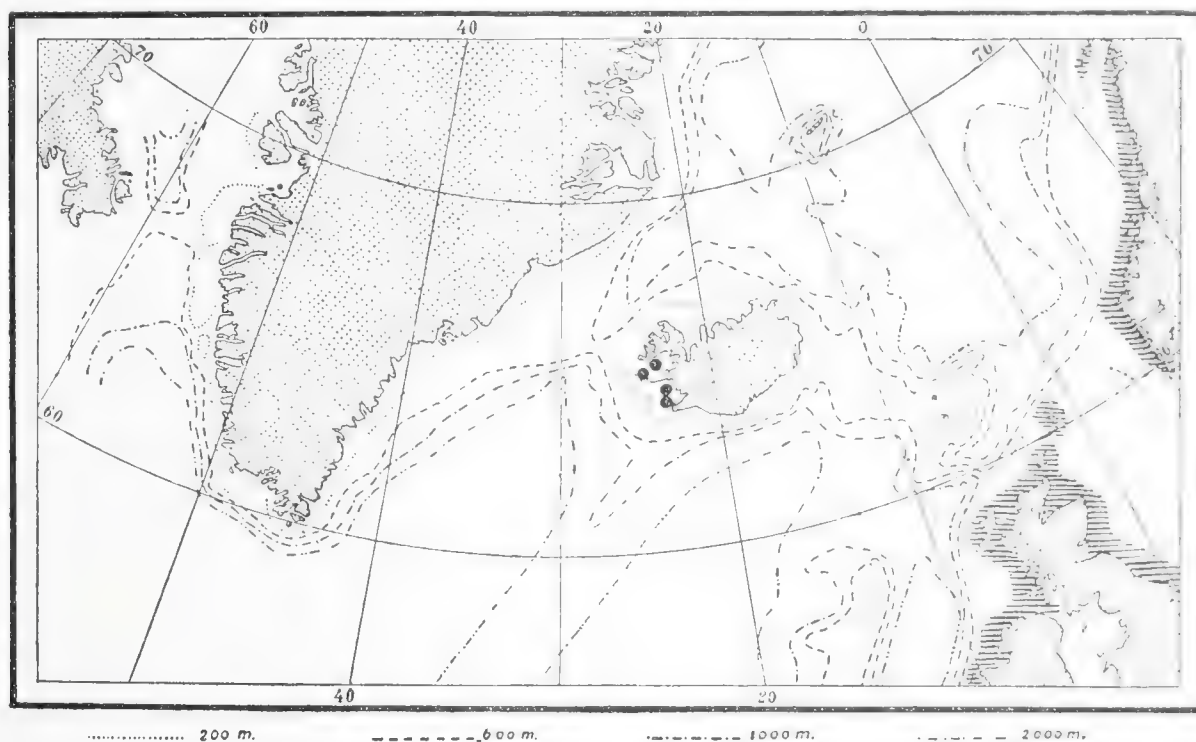
Then only remains the group of *Lampra*, whose gonophores are cryptomedusoid. A generic separation between, for instance, the species of *Lampra* and *Corymorpha (Monocaulus) glacialis*, will, as I have recently pointed out (1915), correspond to a generic separation between ♂ and ♀ in *Tubularia indivisa* Linné or *Tubularia regalis* Boeck. A particular argumentation of the unnaturalness of this limitation is hardly required. But then it is obvious, as a matter of course, that a generic separation of the species of *Lampra* and the other species of *Corymorpha* cannot be maintained. Also the species of *Lampra* must be ranked within the genus *Corymorpha*.

***Corymorpha nutans* M. Sars.**

1835 *Corymorpha nutans*, M. Sars, Beskrivelser og Iagttagelser p. 7, Pl. 1, Fig. 3.

The hydrocaulus, when extended, attains a height of 100 mm. It is broad at the basis, attached to the substratum by numerous rhizoids, and tapering upwards till it reaches its least breadth closely below the polyp. The basis of the polyp is broad and surrounded by a proximal whorl consisting of up to 50 tentacles, which, when extended, attain a length of 30 mm. The distal tentacles are small and placed round the orifice in a main whorl composed of several irregular circles quite closely set.

The gonophores are developed into free medusae with four radial canals, one well-developed tentacle and three rudimentary ones. The gonophores are developed on 15—20 blastostyles, arising



Text-fig. G. The habitat of *Corymorpha nutans* in the Northern Atlantic.
(In the hatched regions the literature denotes a scattered, although common occurrence).

closely above the proximal whorl of tentacles. The blastostyles bear small alternating branches, each provided with a large number of gonophores.

Material:

Iceland, 16 minutes N. W. Akranes, depth 26—30 fathoms (a couple of young polyps).

The occurrence of the species is typically boreal. It is indigenous to the middle parts of the littoral region. Towards the north it goes along the coast of Norway as far as Lofoten and towards the south it penetrates to the northern parts of France. The species is recorded by Jäderholm (1909) from Matotschkin Schar (Nova Zembla) at the depth of between 2 and 5 fathoms. This find is most peculiar and mysterious. *Corymorpha nutans* occurs not rarely in the North Sea, and I think Hartlaub (1907) is right in supposing the specimen from the North Sea recorded by me (1905) as a *Cory-*

morpha, to be in fact a young colony of *Corymorpha nutans*. Remarkably enough, the species has not yet been met with at the Faroe Islands; but it has been found several times on the west side of Iceland. At Greenland it is not likely to occur; nor has the species as yet been recorded from this locality.

***Corymorpha glacialis* M. Sars.**

1859 *Corymorpha glacialis*, M. Sars, Om Ammeslægten Corymorpha.

1872 *Monocaulus glacialis*, Allman, A Monograph of the Gymnoblastic or Tubularian Hydroids, p. 396.

1876 *Amalthæa islandica*, Allman, Diagnoses of new Genera and Species of Hydroida, p. 256, Pl. IX Fig. 5—6.

? 1887 *Tubularia regalis*, Bergh, Goplepolyper fra Kara-Havet.

Nec 1893 *Amalthæa islandica*, Levinsen, Meduser, Ctenophorer og Hydroider fra Gronlands Vestkyst, p. 151.

The hydrocaulus, when extended, attains a height of 100 mm. It is wide at the base, where it is attached to the substratum by numerous rhizoids, and is gradually tapering upwards till closely below the polyp where its width reaches its minimum. The polyp has a broad base, surrounded by a whorl of up to 50 tentacles, which, when extended, attain a length of 30 mm. The distal tentacles are small and numerous, placed round the orifice in a main whorl formed by several irregular and closely set circles.

The gonophores are eumedusoid, with four radial canals, but without rudiments of tentacles. They are sessile. The gonophores are scattered all over the surface of 30—35 unbranched blastostyles, the oldest and most developed ones at the apex of the blastostyle.

Material:

Iceland, Øfjord (without particular data). Original specimen of *Amalthæa islandica*.

? The Kara Sea ("Dijmphna". Particular data are wanting). Labelled *Tubularia regalis*.

The original specimen in hand of *Amalthæa islandica* Allman (1876) proves as clearly as desirable that this species is wholly identical with *Corymorpha glacialis*. Allman, certainly, states that the gonophores of the species are provided with four short tentacles, which are also, in his rather skeletonlike drawings, delineated as rather considerable formations. But in the original specimen can only in some straggling gonophores be pointed out some accidental wrinkles, which, when acting in good will, we may consider as the origin of the rudimentary tentacles stated. Other divergencies from the typical *Corymorpha glacialis* are, on the whole, not traceable.

A specimen from the Kara Sea has been identified by Bergh (1887) as *Tubularia regalis* Boeck. The specimen is an unquestionable *Corymorpha* and no *Tubularia*; indeed, everything suggests that it is a *Corymorpha glacialis*, but the state of preservation impedes a safe identification.

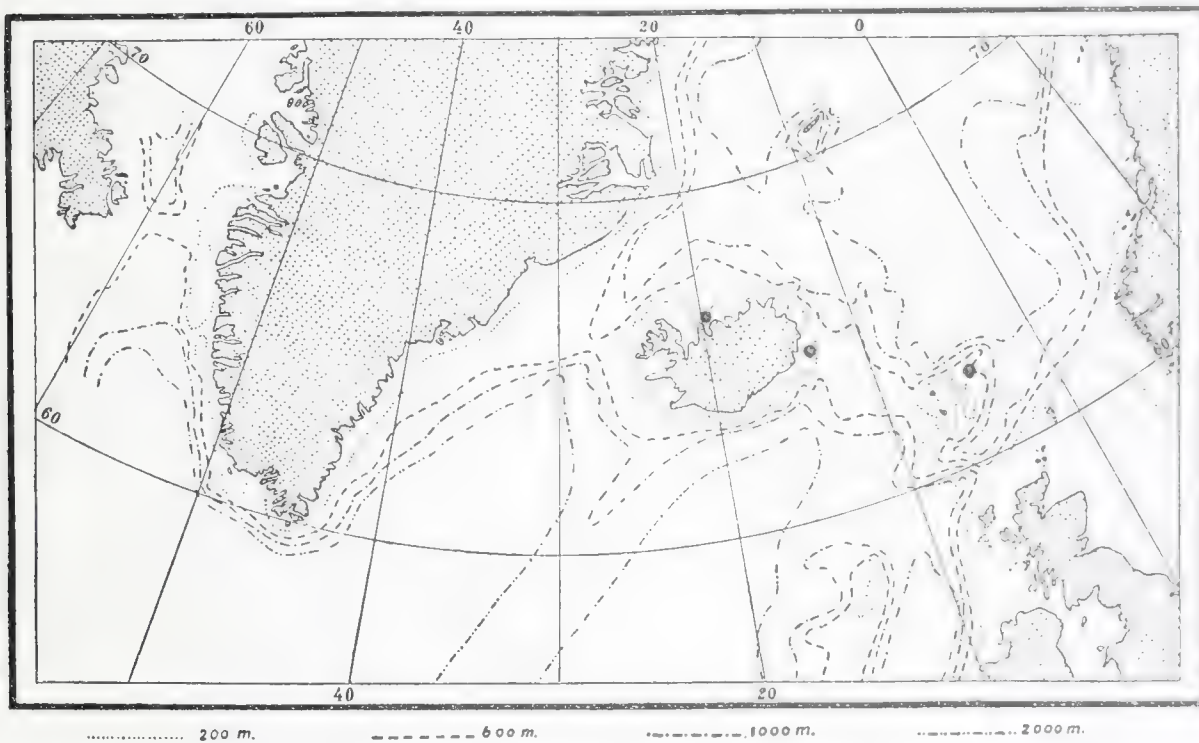
According to the particulars in hand *Corymorpha glacialis* is indigenous mainly to Arctic waters. It has been recorded from the Varanger fjord (M. Sars 1859), from Nova Zembla (Marenzeller 1877), and from Spitzbergen (Broch 1909). But the species also penetrates into warmer water

layers, as is seen (Text-fig. H) from the finds to the north east of the Faroe Islands and on the south east coast of Iceland (Broch 1903). As new localities must be added Northern Iceland (Ölfjord). On the other hand, the specimens from Davis Strait, recorded by Levinsen (1893) as *Amalthaea islandica*, prove to belong to *Corymorpha groenlandica* (Allman).

***Corymorpha groenlandica* (Allman) Broch.**

1876. *Monocaulus groenlandica*, Allman, Diagnoses of new Genera and Species of Hydroida, p. 257, Pl. IX, Fig. 7—8.

1893. *Amalthaea islandica* + *Monocaulus groenlandica*, Levinsen, Meduser, Ctenophorer og Hydroider fra Gronlands Vestkyst, p. 151.



Text-fig. H. Finds of *Corymorpha glacialis* in the Northern Atlantic.

1899 *Lampra atlantica* + *Lampra purpurea*, Bonnevie, Norske Nordhavs-Expedition, p. 20, Tab. II Fig. 4, Tab. III Fig. 1.

1903 — *socia*, Swenander, Über die athecaten Hydroiden des Drontheimsfjordes, p. 6, Taf. Fig. 1—3.

1909 — *arctica*, Jäderholm, Hydroiden, p. 41, Taf. I Fig. 9—10.

1909 *Corymorpha spitzbergensis*, Broch, Die Hydroiden der arktischen Meere, p. 140.

1915 — *groenlandica*, Broch, Hydroiduntersuchungen IV, p. 11.

The hydrocaulus, when extended, attains a height of 100 mm; it is widest at the base, where it is attached to the substratum by numerous rhizoids, and is gradually tapering upwards till close below the polyp where the width reaches its minimum. The polyp has a wide base, surrounded by

a basal whorl of up to 37 tentacles, which, when extended, attain a length of 40 mm. The distal tentacles, when extended, attain a length of 9 mm; they are placed in large numbers round the mouth in a main whorl formed by two or more irregular and closely set circles.

The gonophores are cryptomedusoid and globular (♀) or sub-oval (♂), often somewhat tapering distally, but without any rudiments of tentacles. The gonophores are supported by unbranched and strongly contractile blastostyles, which, when extended, attain a length of 40 mm. The gonophores first ripen at the apex of the blastostyle. As many as 32 blastostyles may occur, but, in general, the number is much smaller; the blastostyles arise close above the basal whorl of tentacles.

Material:

"Ingolf" St. 102. 66°23' N., 10°26' W., depth 750 fathoms, ÷ 0°9 C.

- 107. 65°33' - 10°28' - — 492 — ÷ 0°3 -

- 139. 63°36' - 7°30' - — 702 — ÷ 0°6 -

Greenland: Godthaab (no particulars) [Allman's original specimen of *Monocaulus groenlandica*].

Davis Strait, depth 100 fathoms [labelled *Amalthaea islandica*].

Iceland: 66°02' N., 11°05' W.

5 miles east of Seydisfjord; depth 435 fathoms.

The fairly well preserved specimens of the material recently collected show the following characters (all the measurements are given in mm).

Nr.	Finds	Height of Hydrocaulus	Blastostyles		Proximal Tentacles		Distal Tentacles		Observations
			Number	Length	Number	Length	Arrangement	Length	
1	"Ingolf" St. 139	90	14	5	?	?	in several close circles	2	Hydrocaulus strongly extended
2	"Ingolf" St. 139	60	15	1-3	?	?	in several close circles	2	Blastostyles very strongly contracted
3	"Ingolf" St. 107	57	13	3.5	26	25	in a double circle formed by alternating displacement	1.5	
4	"Ingolf" St. 102	45	10	5	23	up to 24	in several close circles	1.5	
5	"Ingolf" St. 102	41	8	5	25	24	in a double row formed by alternating displacement	2	
6	Davis Strait	40	20	7	24	25	in several close circles	5	
7	"Ingolf" St. 107	?	10	6-13	21	30	in three irregular rows formed by alternating displacement	1.5	Hydrocaulus more than 50 mm high
8	"Ingolf" St. 102	?	9	4	28	up to 23	in several close circles	2	
9	"Ingolf" St. 107	?	16	3-4	24	22	in a double row formed by alternating displacement	2.5	
10	66°2' N. 11°05' W.	?	28	5-18	22	25-30	?	?	Blastostyles placed alternately; attempt at forming two rows
11	"Ingolf" St. 107	?	14	4	18	18	in three irregular rows formed by alternating displacement	2	

HYDROIDA

The species, which is widely distributed in the deeper parts of the cold area, has been found by several expeditions, and has formed the base of the genus *Lampra* stated by Bonnevie (1898, 1899). I have already in works earlier published pointed out that, for several reasons, this genus cannot be maintained. In the first place, the name of *Lampra* had already been applied to a subgenus of the beetle family *Buprestidae*, and should, therefore, disappear among the hydroids, according to the rules of nomenclature internationally adopted. Secondly the characters distinguishing *Lampra* from *Corymorpha* are not sufficient to justify a separation of genera.

A closer examination of the numerous northern species of *Lampra* described will show their un-maintainability. A survey of the figures forming distinguishing characters is obtained by grouping the criteria stated as follows:

Nomenclature	Height of Hydro-caulus	Blastostyles		Tentacles				Gonophores
		Number	Length	Number	Length	Arrangement	Length	
<i>Monocaulus groenlandica</i> Allman 1876.	1 inch	7-8	?	ca. 20	"Moderately long"	"numerous"	short	no tentacles
<i>Lampra arctica</i> Jäderholm 1909	45 mm	22	5-8 mm	25	25 mm	5-6 close circles	?	globular, broadly oval with rounded apex
<i>Corymorpha spitzbergensis</i> Broch 1909..	60 mm	12	5 mm	25	20 mm	4-5 close circles	2 mm	oviform or globular without tentacles
<i>Lampra atlantica</i> Bonnevie 1899	80 mm	10	4-6 mm	10	10-20 mm	several close-set circle	?	without tentacles
<i>Lampra purpurea</i> Bonnevie 1899	100 mm	10	30-40 mm	30	30-40 mm	two circles	?	without tentacles
<i>Lampra socia</i> Swenander 1903	45 mm	18-32	till 25 mm	29-37	35 mm	numerous close-set circles	up to 9 mm	♀ more rounded, ♂ sub-oval, without tentacles

The original discription given by Allman (1876) is founded on a series of young individuals from Godthaab, in which it may be observed how the number of proximal tentacles increases by new tentacles being established and growing out among the old ones. How far the number of tentacles may increase in this way, cannot be settled. But no definite rule of the increase being traceable, we here face one of the reasons of the great varying of the numbers of tentacles. In these young individuals it is also interesting to observe that the distal tentacles are established quite irregularly (Tab. II Fig. 14), and that the blastostyles arise as simple fingerformed bulges of the polyp wall. The gonophores only appear at a rather late stage of development.

The skeletonlike figures and rather deficient diagnosis of the species given by Allman long impeded its recognition, and, therefore, only a couple of specimens occurring in the museum of Copenhagen have later on been correctly referred to his species *Monocaulus groenlandica*. Bonnevie (1899) accordingly describes two new, closely related species, *Lampra atlantica* and *Lampra purpurea*. The former species is distinguished from the latter mainly by its small number of tentacles, having only ten proximal ones. However, even though this difference must be regarded as very large, as far as in the single specimen of *Lampra purpurea* as many as thirty proximal tentacles have been observed, we cannot acknowledge it as a sufficient specifical distinguishing character after the examination of a larger material of the species. The rather numerous specimens found in the Trondhjem fjord present

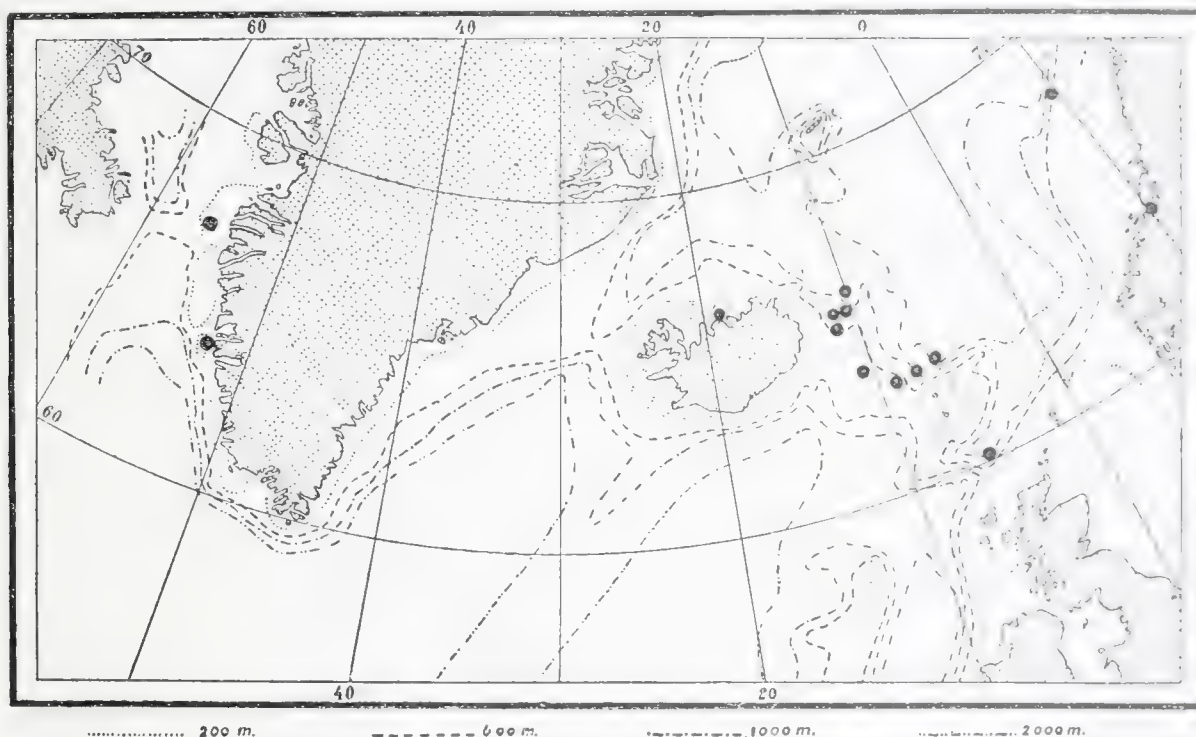
so great a range of variability that the number stated in *Lampra atlantica* must only be considered as an extreme variation. The variation of the individuals found in the Trondhjem fjord is even larger than stated by Swenander (1903); individuals have been found with only 15 tentacles in the proximal whorl. The difference in the shape of the gonophores, being either subglobular or oval with attempts at tapering, is of little importance. Swenander points out that the female gonophores are more globose, the male more oval. In a specimen picked up north east of the Seydisfjord (Iceland) the gonophores are partly globular, partly oval, with the same attempt at tapering towards the distal end as is shown in the figure of Bonnevie (1899, Tab. III, Fig. 1a). However, one criterion is still left, the distal tentacles of *Lampra purpurea* being arranged in two separate circles, while in other species they are placed in several irregular and close-set circles. From the comments of Bonnevie it appears that the description has mainly been based on the drawings of G. O. Sars, which were executed on board ship. In these drawings the double whorl is not peculiarly clearly rendered; nor can, from the remnants of the original specimen kept, the character be ascertained any longer. From the table set up of the specimens from the Danish collections, however, it appears that, from individuals with a distal whorl consisting of two rows to individuals with a distal tentacle whorl of several rows, every transition may be pointed out. Thus neither this table nor the criteria stated in the other table may be turned to account for the purpose of attaching any peculiar systematical importance to this character. *Lampra atlantica* and *Lampra purpurea*, therefore, cannot be recognized as two separate species, and are moreover identical with *Corymorpha groenlandica*.

For a thorough examination of the species we are indebted to Swenander (1903), who considered the *Lampra* of the Trondhjem fjord as a peculiar species, *Lampra socia*. From what I have stated above, the shape of the gonophores, applied by Swenander as a main character distinguishing the species from *Lampra purpurea* Bonnevie, cannot be maintained as a criterion. The number of the blastostyles then remains; Bonnevie, for both the species mentioned, states 10 blastostyles; Swenander, for *Lampra socia*, 18—32. Still Swenander has not found the minimum for the individuals of the Trondhjem fjord; as a matter of fact, specimens with only 15 blastostyles are now in hand. In the Danish material collected from the northern Atlantic the number is throughout lower, varying from 10 to 28, thus bridging the difference between *Lampra socia* and the species stated by Bonnevie. Also the other distinguishing characters, the emphatic demarkation of the hydrocaulus from the polyp, or its gradual transition into the latter, and the colour of the animals, are varying from one individual to the other, forming no strongly defined limits. The demarkation of the stem from the polyp more or less emphatic, is, in living individuals, varying according to the state of contraction, as in other species of *Corymorpha*. Therefore, also *Lampra socia* must be considered as a synonym of *Corymorpha groenlandica*.

Jäderholm (1909) and Broch (1909) describe two new species, respectively *Lampra arctica* and *Corymorpha spitzbergensis*. The table at once shows that they come within the range of variation of *Corymorpha groenlandica*. As to *Lampra arctica* the short and thick blastostyles, maintained by Jäderholm (1909) as a good criterion, are in fact to be looked upon as a mere phenomenon of contraction which may be partly observed even in preserved material, where in the same individual some blastostyles may be short and thick, while others are thin and strongly extended. Illustrative in this

respect is the individual nr. 10 of the first table, the length of the blastostyles varying from 5 to 18 mm., and the thickness being inversely proportional to the length. The rest of the distinguishing characters fall under what has been earlier stated.

Corymorpha groenlandica is a typical form characteristic of the great deep of the cold area. It proves to be widely distributed, from Spitzbergen to the Faroe Islands, and from Norway to Greenland. It has also been recorded from Davis Strait. In the seas far to the north it rises to more shallow waters. Thus it has been recorded near Spitzbergen at the depth of only 45 metres (Broch 1909). A remarkable geographical exception is formed by the occurrence of the species in the deeper Atlantic



Text-fig. I. Localities of *Corymorpha groenlandica* in the Northern Atlantic.

strata of the Trondhjem fjord. At present the occurrence of the species in this locality cannot be accounted for. But a great deal may be said in favour of the notion that we have here in hand a relict form, which has been able to accommodate itself to the altered circumstances in the same way as *Tubularia regalis* Boeck and *Stegopoma plicatile* (M. Sars) which are rather frequently occurring on or at the *Lophohelia* reefs of the fjord.

Corymorpha sp. indet.

Indeterminable remnants of species of *Corymorpha* occur from the following localities:

"Ingolf" St. 28, 65°14' N., 55°42' W., depth 420 fath., + 3°5 C., attached to the tube of a *Pectinaria*.

— - 124, 67°40' - 15°40' - — 495 — ÷ 0°6 -

Section Filifera Kühn.

Family Clavidae.

Hydroids forming colonies, with polyps fusiform or capitate, the distal part of which is conically tapering. The stinging cells are small and rodformed. The tentacles are filiform, irregularly distributed over the body of the polyp, now and then showing a heterogeneous development or even reduced to a single large tentacle. The endoderm forms a homogeneous gastral cell-layer through the whole of the polyp. The colonies have no calcareous skeleton.

The family *Clavidae*, as it is here defined, includes the genus much in dispute *Monobrachium*, which has been distinguished by most investigators as the representative of a family of its own, *Monobrachiiidae*. This family is maintained even by Kühn (1913), who has obviously failed to notice the significant pointing out by Vanhöffen (1909) of the heterogeneous development of the tentacles of *Campaniclava clionis* Vanhöffen, forming an obvious link between *Monobrachium* and the other *Clavidae*. Vanhöffen, therefore, does away with the family *Monobrachiiidae* and refers *Monobrachium* to *Clavidae*. In this he is rightly followed by Stechow (1913).

Gen. *Clava* Gmelin.

The reptant colonies have polyps capitate or subfusiform with filiform tentacles irregularly distributed over the polyp. The proboscis is conically pointed. The hydrocauli are not surrounded by any distinct stiff perisarc. The gonophores are clustered on the polyp below the portion bearing tentacles, or seated on the reptant stolons either solitary or in clusters.

According to this diagnosis also the genus *Rhizogeton* must be included under *Clava*. The two genera have hitherto generally been distinguished on the ground that in *Rhizogeton* the gonophores are seated on the stolons, while in *Clava* they are borne by the polyp itself. This criterion, however, is too insignificant to justify a division of genera, and it is also suggested by Stechow (1913) that very likely the two genera have to be united. In his key of genera, indeed, Stechow puts down *Rhizogeton* in a parenthesis under *Clava*.

Clava multicornis (Forskål) Gmelin.

1775 *Hydra multicornis*, Forskål, Descriptiones animalium, p. 131.

1776 *squamata*, Müller, Zoologia Danicæ Prodomus, p. 230.

1788 *Clava parasitica*, Gmelin, in Linné: Systema natura Ed. 13, vol. I, p. 3131.

On the reptant stolons the capitate or almost fusiform polyps are placed in close or opener clusters. The stem of the polyp is without perisarc. The filiform tentacles are irregularly distributed over the distal parts of the polyp.

The gonophores are cryptomedusoid, and placed in larger or smaller groups like clusters of grapes closely below the portion of the polyp bearing the tentacles.

HYDROIDA

The species may be divided into two forms:

Forma *genuina*, growing, in colonies more openly constructed, on stones and shells (*Mytilus*); it is delicately built and bluish or rose-coloured.

Forma *squamata* forming clusters of polyps more brick-coloured or yellowish-red on the leaves of *Fucoideae*; its polyps are large and robustly built.

Material:

Iceland: Reykjavik

depth 3–4 fathoms.

Vestmannaey

on the shore (on *Fucoideae*)

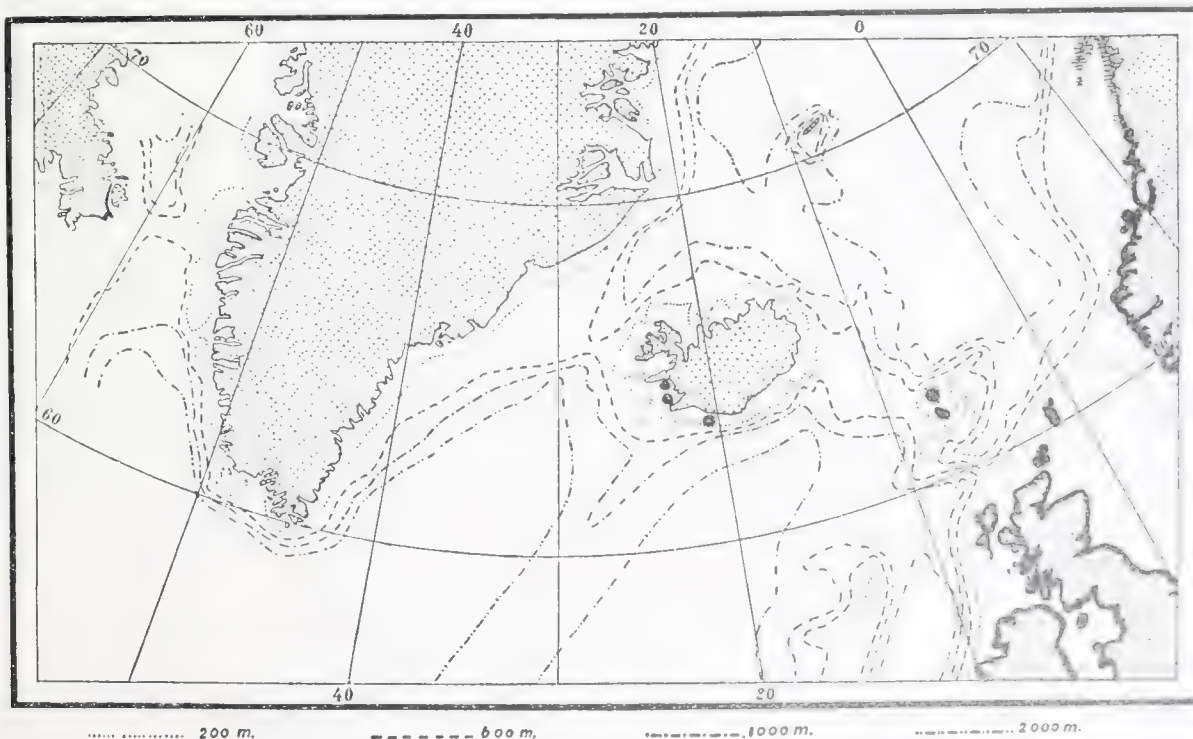
The Faroe Islands: Sundelaget

north of Kvalvik

on the shore (on *Fucoideae*)

(There also occur specimens marked "Faerö" without particular data).

Clava multicornis and *Clava squamata* are recorded by most investigators of hydroids as two separate species; the distinguishing characters, however, are rather vague, being made out by the closer or opener occurrence of the polyps in the colony or by the colour of the colonies. A copious material from various localities, in fact, presents all transitions possible, and it is virtually impossible to draw any certain limit between the species. A closer inquiry soon makes clear to us that the points of difference must be of biological nature, and the two species, therefore, have to be regarded only as biologically determined "forms" of a single species, which I, accordingly, denominate forma *genuina* and forma *squamata*. The occurrence of typical colonies of the forma *genuina*, which are, in



Text-fig. K. The distribution of *Clava multicornis* in the Northern Atlantic
(In the hatched part of the Norwegian coastal region the occurrence is rather scarce)

fact, rather rare and scattered, is bound to substrata of stones, which may be, at a pinch, replaced by the shell of a *Mytilus*, while the colonies luxuriantly developed of the forma *squamata* are resident on the leaves of the *Fucoideae*, where certainly the supply of food is much more copious.

The description of Forskål (1775) being older than that of O. F. Müller (1876), we have according to the rules of nomenclature in force, to drop the specific name employed by the latter, *Clava squamata* and to maintain the denomination bestowed on the species by Forskål, *Clava multicornis*. Its limitation from the American species *Clava leptostyla* L. Agassiz, has not as yet been ascertained, and it seems on the whole questionable if the two species are really to be distinguished.

Clava multicornis is a boreal species, which seems, nevertheless, to be able to penetrate far into the Mediterranean (Babić 1904). It is a littoral form, and forma *squamata* has been found only in the tidal zone; forma *genuina*, on the other hand, at rare intervals, has been met with a little beneath the tidal zone in places with rather small salinity. Fabricius (1780) records the occurrence of the species at Greenland without particular statement of locality; however, it has not afterwards been observed in this place. On the other hand, the species seems to occur not unfrequently on the south west coast of Iceland. It is frequently met with at the Faroe Islands, and is found everywhere round the British Isles and on all coasts round the North Sea. Its occurrence at the northern parts of the coast of Norway is not sufficiently accounted for, but does not seem to be particularly frequent.

Gen. *Merona* Normann.

From the reptant stolons arise unbranched, chitinous polyp stems. In the upper part of the stem the perisarc is so wide that the polyp can be retracted into it, though development of a hydrotheca is not indicated. The filiform tentacles are irregularly spread over the polyp. The gonophores are borne upon reduced polyps (blastostyles) arising from the reptant stolons.

With great hesitation I set up *Merona* as a genus of its own. It is distinguished from *Corydendrium* van Beneden (1844) only in mere trifles of no great importance. Thus its polyp stems are unbranched, while the hydrocaulus of *Corydendrium* is richly branched. Another distinguishing character may perhaps be sought in the quality presented by *Merona* in its wide perisarc, into which the polyps are retractile. But none of these criteria can be said to be of properly generic value. When, nevertheless, *Merona* is provisionally maintained, it is due to the fact that only an exceedingly scarce material of a single species is in hand, and that the state of preservation of this material allows of no closer inquiry into the polyps.

Merona cornucopiae Norman.

1864 *Tubiclava cornucopiae*, Norman, On undescribed British Hydrozoa, Actinozoa and Polyzoa, p. 357.

1865 *Merona* — Norman, On *Merona*, an undescribed genus of British Hydrozoa, p. 262.

The hydrocauli are unbranched and attain a height of about 5 mm.; the stems are narrowest at the base and increase gradually in diameter till they attain their greatest width closely below the

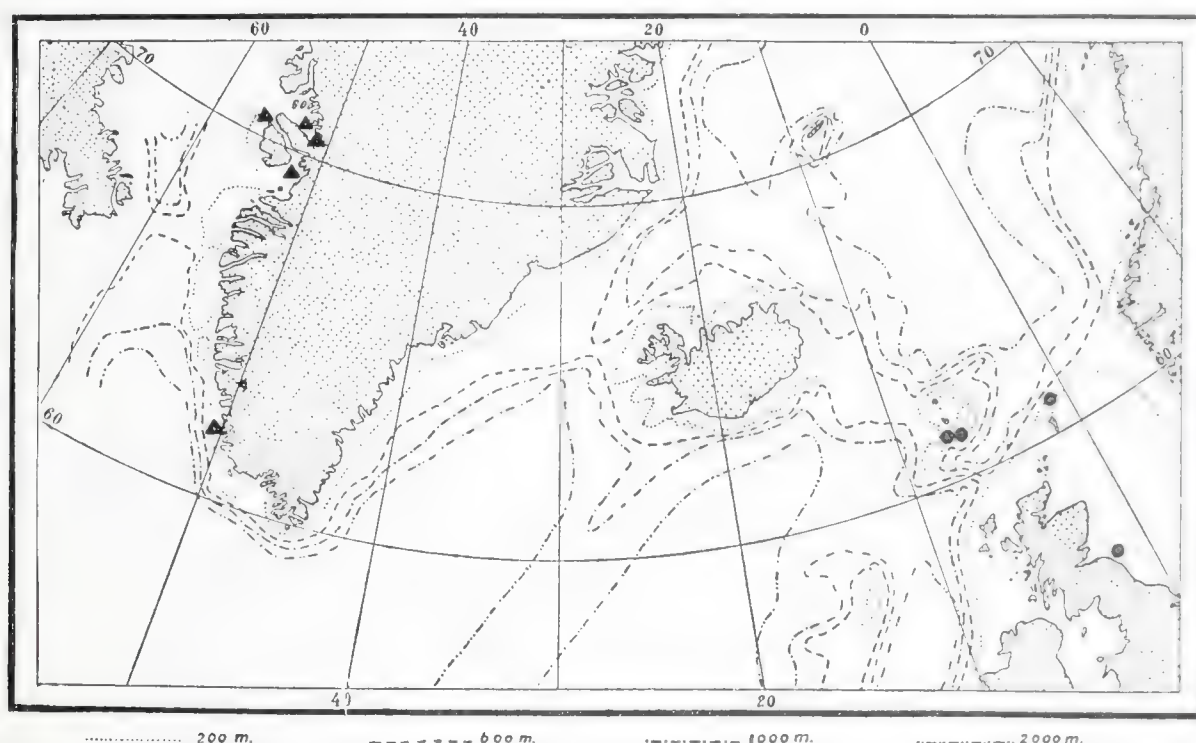
extended polyp; they are without rings; at most there is some faint and irregular wrinkling here and there. The polyp is fusiform with the tentacles irregularly distributed all over the surface: the polyp may be retracted into the broader distal portion of the hydrocaulus.

The structure of the gonophores seems to be strongly reduced. They are developed at the upper part of blastostyles without tentacles, at most 1 mm. high.

Material:

The Faroe Islands: 13 miles West to South of Munken, depth 150 fath. (on *Cardium* sp.).

- - - 9 - East South East of Bispen, - 70 - (- - -).



Text-fig. I. Localities of *Merona cornucopiae* ● and *Monobrachium parasitum* ▲ in the Northern Atlantic.

Merona cornucopiae was first described as a *Tubiclava* by Norman (1864). But as the latter genus is characterized by the gonophores being borne on the polyps, he thought he had better set up a new genus *Merona* (1865) for the species in hand, bearing its gonophores on polyps strongly reduced or on blastostyles. This criterion, however, is of subordinate importance and would by no means justify the separation of two genera. However, from the drawings occurring in literature, a much essential point of difference urges itself. The perisarc of the species of *Tubiclava* is not so wide that the polyp can be retracted into it, while this is the case with *Merona*. The division, therefore, seems well founded. But at any rate a renewed examination of the two genera is needed.

Merona cornucopiae seems only to occur attached to shells of living mollusks, and the latter found on species of the genera *Cardium*, *Astarte*, and *Dentalium*. The species does not seem to be very frequent; it has previously been recorded from the sea to the north of the Shetlands at the depth of 80—100 fathoms, and from the coast of Northumberland. To these localities are now to be

added the seas to the south of the Faroe Islands at the depth of 70—150 fathoms. All the finds are thus situated in the boreal area, on the border of the warmer Atlantic regions (Text-fig. L).

Gen. *Monobrachium* Mereschkowsky.

Reptant colonies, whose cylindric polyps are provided with a solitary large tentacle. Besides the nourishing individuals bearing tentacles, also machozoids with no mouth and no tentacles occur. The polyps have no distinct stem and are not covered with perisarc. The gonophores are eumedusoid and attached to the stolons.

The very peculiar Arctic genus of hydroids first described by Mereschkowsky (1877) has been more closely investigated by Wagner (1890) and Bonnevie (1899). In the only species known of this genus the eumedusoid gonophores have a rudimentary spadix, and the germ cells are accordingly developed along the radials canals. On this ground Bonnevie maintains that the species is closely related to the *Leptomedusae*, and that the genus has to be placed proximately between athecate and thecaphore hydroids. Kühn (1913), on the other hand, holds that the organisation of the gonophore cannot be considered as any certain proof justifying such a supposition, and points out that the transition of the gonophore from independent free existence into sessile mode of life can effect a secondary displacement of the gonads in many different ways without any necessity that this should be indicative of nearer or remoter relationship. Apart from this, however, there is an additional reason against the supposition of Bonnevie. As is pointed out by Vanhöffen (1909), we have in hand a medusa-form obviously nearly related, *Catablema*, which, when somewhat damaged, is very easily mistaken for a *Leptomedusa*, but which is, in fact, a genuine *Tiaride*. Vanhöffen even presumes that *Catablema* really is the medusoid generation of *Monobrachium*. But in that case it remains to show that the gonophores of *Monobrachium* are not sessile as they have hitherto generally been supposed to be.

The explanations of Vanhöffen (1909) and Kühn (1913) make good that *Monobrachium* takes no intermediate place between athecate and thecaphore hydroids. But the place of the genus among the athecate hydroids would still be equally uncertain if the peculiar species *Campaniclava clionis* Vanhöffen (1909) had not shown us, by its heterogeneous development of the tentacles, the unquestionable link between *Monobrachium* and the normal-looking forms of *Clava*. Therefore there is no reason any longer to regard the genus as the representative of a peculiar family; as pointed out by Vanhöffen, it ought to be classed with the *Clavidae*.

Monobrachium parasitum Mereschkowsky.

1877 *Monobrachium parasitum*, Mereschkowsky, On a new Genus of Hydroids, p. 225, pl. 5 fig. 1—6
pl. 6 fig. 7—14.

1899 — *parasiticum* Bonnevie, Norske Nordhavs Expedition, p. 51.

Reptant colonies, whose polyps are dimorphically developed; beside cylindric polyps with orifice and a vigorous tentacle, also machozoids without mouth or tentacles occur. The nourishing

polyps are provided with a ring of stinging cells above the base of the tentacle. The stolons form a network of anastomosing tubes.

The gonophores are eumedusoid with a rudimentary spadix and with the generative cells placed along the four radial canals. The colonies are bisexual.

Material:

Greenland: Egedesminde (on *Tellina calcarea*).

The Kara Sea ("Dijmphua").

Monobrachium parasitum is indigenous to the middle parts of the litoral region far to the north. It is recorded from Spitzbergen, the Kara Sea, the White Sea, and the west coast of Greenland (Text-fig. L).

Family Bougainvilliidae.

Hydroids forming colonies with polyps fusiform or capitate, whose oral portion is conically pointed. The stinging cells are small and rodshaped. The tentacles, which are filiform, are placed in a main whorl round the polyp; the stinging cells are equally distributed all over the surface of the polyps or in less distinct transverse belts round them. The polyps are quite naked or surrounded by a jellied, lithe, and pliable pseudohydrotheca below the tentacle whorl. The endoderm is differentiated into an oral portion, consisting of indifferent small-nucleated cells between which occur a large number of mucous gland cells, and the proper gastral portion; the limit is formed by the tentacle whorl. The colonies have no calcareous skeleton.

The diagnosis states for the family the same range as was practically already given by Bonnevie (1899), whom the later authors have generally followed. Kühn (1913) divides the family into three subfamilies, two of which, *Hydractiniinae* and *Atractylinae*, are represented in our northern seas. The main distinguishing mark stated by Kühn is that *Hydractiniinae* are stated to have a vigorous, crustformed skeleton, while *Atractylinae*, on the other hand, have hydrocauli covered with periderm. However, this character does not seem to be of the importance Kühn attached to it. In young colonies the stolons have not coalesced into a crust, and the development of the skeleton is not particularly vigorous. There is even every probability that several species of *Stylactis* do not at all assume such crustformed skeleton-formations, even when advanced in life. On the other hand, we also know species of *Hydractiniinae*, in which the hydrocaulus covered with periderm has been reduced to a mere minimum. The character, therefore, must be characterized as a merely gradual one, and can hardly be turned to account as fundamentum divisionis for higher groups.

A very different interest is attached to the peculiar occurrence of pseudohydrothecae met with in the *Bougainvilliidae*. I set aside the so-called pseudohydrothecae of *Clathrozoön* (the subfamily *Hydroceratininae*, stated by Kühn 1913); in fact, this group is not yet so well known that we are able to judge of it entirely, and its "pseudohydrothecae" do not seem to form such a parallel with the formations of the thecaphores as those found in certain other *Bougainvilliidae*, namely in *Perigonimus*. In this species the ectoderm of the polyp has discerned a jellied pseudohydrotheca, which has coalesced with the polyp along its distal margin, and to which the basal portion of the supporting

lamella of the polyp is attached by small chitinous bodies similar to those found in several thecaphores. This pseudohydrotheca is but little visible, or, with intact polyps, when they are extended, almost untraceable, while in contracted polyps it lies round the basal portion of the polyp like a cup richly folded. It might be obvious to regard it as the precursor of the real hydrotheca. Perhaps it might be regarded as a character sufficiently important for the purpose of distinguishing a subfamily: However, the matter has, as yet, been too little examined as to allow the forming of a reasonable opinion; we have, provisionally, to regard it as a generic character.

Gen. *Hydractinia* van Beneden.

The stolons of the reptant colonies, when young, will generally form an open meshwork which afterwards most frequently changes into a continuous chitinous crust. The crust is commonly carrying spines of various appearance, or may grow out into branched formations of colonies. The polyps are cylindrical or capitate with conically pointed oral portion. The tentacles are placed in a whorl below the mouth. There is no erect hydrocaulus covered with perisarc. The polyps are heterogeneously developed into larger nourishing individuals bearing tentacles and into spiralzooids bearing no tentacles; the latter occur at the extremities of the colonies. — The gonophores are supported by polyps more or less transformed (blastostyles) or arise directly from the stolons.

According to this diagnosis, also *Podocoryne*, *Oorhiza* and *Stylactis*, earlier set up as genera are included under *Hydractinia*. The only reason of distinguishing between *Hydractinia* and *Podocoryne* has been sought in the power of the last-mentioned genus of producing free-swimming medusae. However, Bonnevie (1899) has described a couple of species, *Hydractinia Allmani* and *Hydractinia ornata*, having medusoid gonophores less strongly reduced with radial canals, and from Africa has been recorded a species, *Hydractinia Michaelsoni* Broch (1914), whose male gonophores are perfect medusae, which, however, do not seem to break away normally. Also Kühn (1913) seems to incline to the opinion that the separation of the two genera is questionable. The intermediate forms of gonophores mentioned, in fact, forbid the drawing of a certain limit between the genera, and, therefore, the proper thing to be done, is, indeed, to draw in *Podocoryne* under *Hydractinia*.

The genus *Oorhiza* is based on the fact that the gonophores are seated, not, as in *Hydractinia*, on blastostyles, but, on the contrary, on a short stem rising directly from the stolons. A review of our northern species of *Hydractinia*, however, shows that, in fact, this criterion is of no vital importance. In *Hydractinia humilis* Bonnevie and *Hydractinia Sarsii* Steenstrup the gonophores are borne on polyps fully developed of the same size as the sterile nourishing individuals; in *Hydractinia carnea* M. Sars the polyps bearing gonophores are, certainly, fully developed individuals, provided with tentacles; but they have a smaller number of tentacles, and are smaller than the sterile nourishing polyps. In *Hydractinia Allmani* Bonnevie, *Hydractinia ornata* Bonnevie, and *Hydractinia echinata* (Fleming) the reduction is carried still further, the tentacles being reduced or wholly disappearing, so that the bearers of the gonophores are here typical blastostyles. In *Hydractinia carica* Bergh, finally, the polyp has been reduced to a stem, round the apex of which the gonophores are

placed in a whorl. In fact, between this condition of things and a solitary gonophore seated terminally on a polyp wholly reduced to a stalk, there is no great gap, and at any rate the criterion is not essential enough to be turned to account as fundamentum divisionis. Also *Oorhiza* has, accordingly, to be included as a synonym under *Hydractinia*.

Stylactis is yet left to be mentioned, being distinguished by the stolons forming an open mesh-work and no continuous chitinous crust. In his excellent elucidation of *Hydractinia* and *Podocoryne*, Hincks (1868) calls attention to the fact that, in the species then known, the stolons at first form an open mesh-work and do not till later on coalesce into a continuous crust. Young colonies of *Hydractinia carnea*, which are in our Norwegian seas very commonly observed on living specimens of *Nassa reticulata*, in most cases show this open mesh-work of stolons and, therefore, easily run the risk of being undiscerningly characterized as *Stylactis*. In the African species, *Hydractinia Michaclseni* Broch and *Hydractinia fallax* Broch, large colonies show a mixture of characters of *Stylactis* and of *Hydractinia*, and, accordingly, there is no reason to maintain the two groups as distinct genera. They communicate with each other by intermediate forms. It is probable that several species of *Stylactis* have been based on young colonies of typical species of *Hydractinia*. This probability, indeed, cannot be contested even by the occurrence of gonophores, because, in young colonies of *Hydractinia carnea*, where the stolons have not yet coalesced into a crust, gonophores are frequently observed. A species as *Stylactis arctica* Jäderholm (1902) has obviously to be judged summarily as such a young *Hydractinia*. Also *Stylactis*, therefore, has to be included among the synonyms of *Hydractinia*.

Hydractinia Sarsii (Steenstrup) Bonnevie.

1846 *Podocoryna carnea*, M. Sars, Fauna littoralis Norvegiæ, Heft 1, p. 7.

1850 *Podocoryne Sarsii*, Steenstrup, in: Lütken, Nogle Bemærkninger om Medusernes systematiske Inddeling, p. 33.

1872 *Stylactis* — Allman, Monograph of the Gymnoblasic or Tubularian Hydroids, p. 303.

1892 *Podocoryne carnea*, Levinsen, Meduser, Ctenophorer og Hydroider fra Grönlands Vestkyst, p. 11.

1899 — — pars, Sæmundsson, Bidrag til Kundskaben om de islandske Hydroider, p. 50.

1899 *Hydractinia sarsii*, Bonnevie, Norske Nordhavs Expedition, p. 45.

The reptant stolons are covered by a continuous chitinous coenosarc, whose surface is studded with small spines, among which are found, often by groups, large, vigorous thorns, up to 0.5 mm. high, of irregular conical shape with closed apex abruptly cut off. The polyps attain a length of 2.5 mm. and have 10 or 20 tentacles in a dense, proximately double, whorl, below the oral portion. Spiral-zooids have not yet been pointed out.

The gonophores are cryptomedusoid and placed, to the number of three or six, round fully developed polyps of the same size as the sterile nourishing individuals.

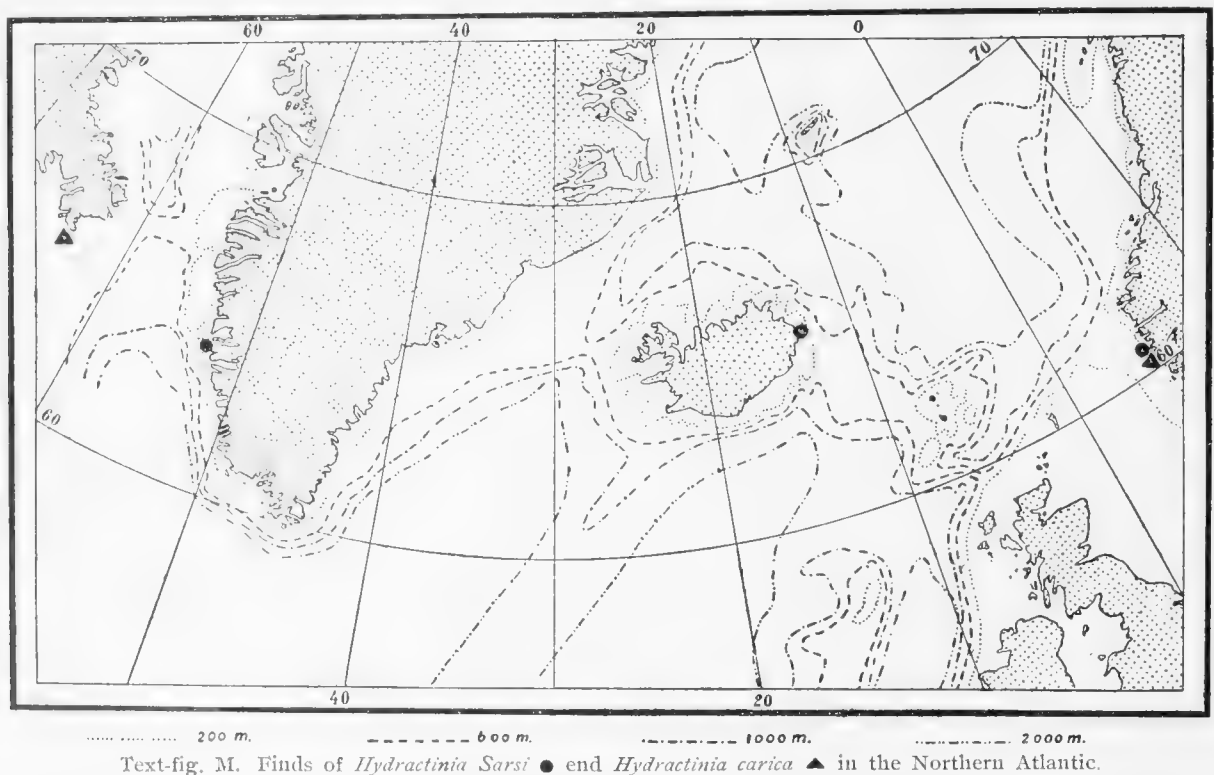
Material:

Greenland, the harbour of Godthaab . . . depth 12 fath. (on *Hyas araneus*).

Iceland, Seydisfjörð (on *Carcinus maenas*).

The well developed colony in hand has been wrongly determined as *Podocoryne carnea*. It is hardly intelligible that Bedot, in his "Matériaux pour servir à l'histoire des Hydroides", should have followed Allman (1872) and referred this species to *Stylactis*; it is one of the few species of *Hydractinia* which, even at the extremities of small colonies, show no indication of the open network of stolons for which *Stylactis* should be distinguished.

The species seems to be a boreal one, but it has hitherto been recorded only from very few localities, as it has probably been mistaken for *Hydractinia carnea* also by investigators subsequent to M. Sars (1846). It has previously been recorded only from the coast of Norway near Bergen. In the Danish collections is found a well developed, though sterile, colony from Iceland (Seydisfjörð), seated on the claw of a strand-crab. It seems to be the same species which is recorded, by the name



of *Podocoryne carnea*, from the north of Iceland, on the operculum of a *Balanus Hammeri* (Sæmundsson 1902, 1911); here is only found the chitinous crust; but it differs considerably from the crust found in *Hydractinia carnea*, and, on the contrary, wholly agrees with *Hydractinia Sarsii* (Tab. I Fig. 12). Finally also West Greenland (Godthaab) has to be added to the localities where the species has been found (Text-fig. M).

Hydractinia echinata (Fleming) van Beneden.

1828 *Alecyonium echinatum*, Fleming, A History of British Animals, p. 517.

1841 *Hydractinie*, van Beneden, Recherches sur la structure de l'oeuf dans un nouveau . . . genre de Polype (genre *Hydractinie*), p. 89.

1909 *Hydractinia monocarpa* pars, Broch, Die Hydroiden der arktischen Meere, p. 199.

The reptant stolons are covered by a continuous chitinous coenosarc, whose surface is studded with small prickles, among which occur larger chitinous spines about 1.5 mm. high, provided with longitudinal rows of more or less regular small teeth. The large spines now and then show a tendency to divide at the apex. The polyps are up to 4 mm. long, whitish or faintly reddish, with 20–30 tentacles in a dense whorl below the oral portion. The tentacles form a belt which appears double because of alternating displacement. Spiralzoids without tentacles occur along the margin of the colony.

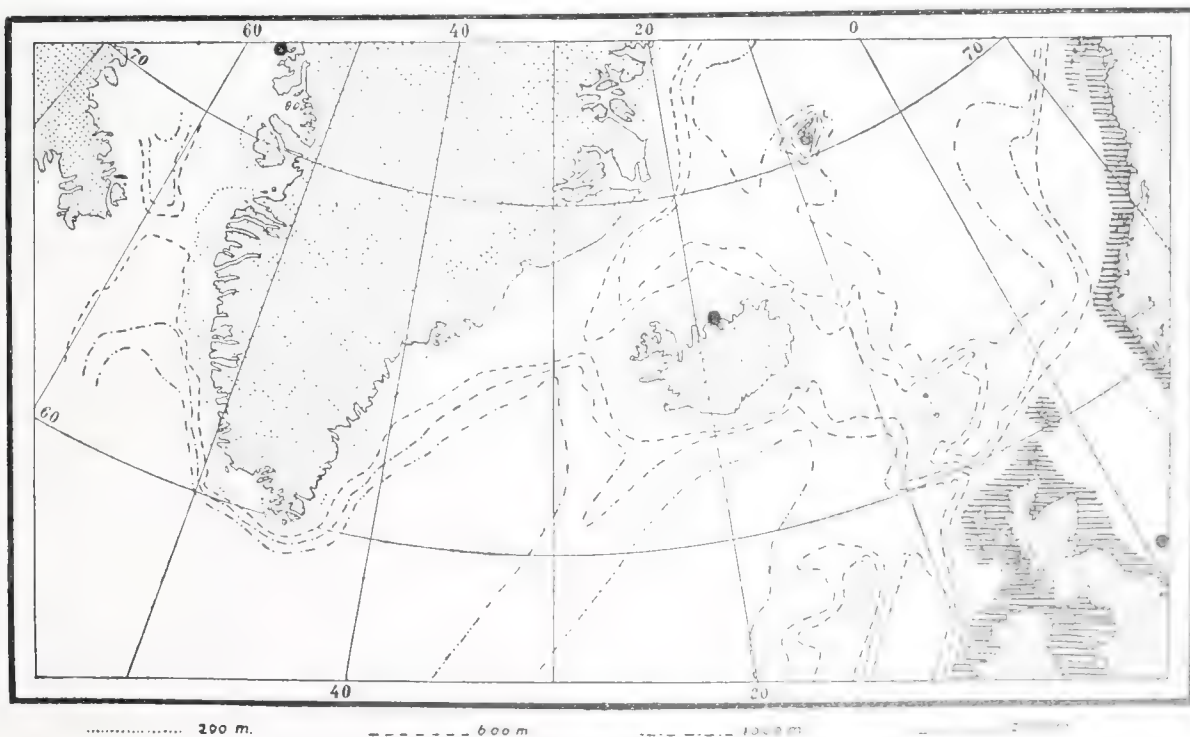
The gonophores are cryptomedusoid, placed, to a number of 3 or 6, round reduced polyps with rudimentary tentacles.

Material:

Greenland: Upernivik, depth 80–90 fathoms without particular data, from a cod's stomach.

Skagerrak: the channel near Vinga (Bohuslän), depth 50 fath.

Hydractinia echinata in its large chitinous skeleton-spines (Tab. I Fig. 9 and 10) has a very typical armour impeding a confusion with other northern species. It is an Atlantic-boreal species, showing a great power of enduring both high and low temperatures. It occurs very frequently in the North Sea, along the coasts of Great Britain and Ireland, goes to the south as far as into the Mediterranean, and is also found on the east coast of North America. The species belongs to the litoral region and almost always goes together with *Eupagurus Bernhardus*, on whose house it settles. When we consider the distribution of the species along both sides of the northern Atlantic, we must wonder that it has not yet been observed at the Faroe Islands, and that only a single specimen has been met



Text-fig. N. The occurrence of *Hydractinia echinata* in the Northern Atlantic.
(The hatched parties denote according to literature a scattered although common occurrence).

with at Iceland. This specimen which was found on the north side of the island, was originally recorded by Winther (1880), and has afterwards been revised by Sæmundsson (1902). It is a peculiarity of the specimen that it is seated on the operculum of a *Balanus Hammeri*, and not on the house of the Bernhardus crab. The species has been recorded once in the Arctic water-layers near Jan Mayen (v. Lorenz 1886). In a previous work (1909) I gave utterance to the supposition that the variety recorded by Levinsen (1892) had probably to be referred to the high-arctic species *Hydractinia monocarpa* Allman. An examination of the specimens mentioned, however, shows that this supposition is wrong. The specimens are unquestionable *Hydractinia echinata* with skeleton strongly developed. One of the specimens is distinguished by being attached to the shell of a living *Buccinum hydrophanum*. The species, thus, proves able to occur now and then under wholly high-arctic conditions.

Hydractinia carica Bergh.

1887 *Hydractinia carica*, Bergh, Goplepolyper fra Karahavet, p. 3, Taf. 28, Fig. 1.

1899 — *minuta*, Bonnevie, Norske Nordhavs-Expedition, p. 48, Tab. I, Fig. 3.

The reptant stolons are covered by a chitinous layer of coenosarc, without small prickles, but bearing here and there vigorous spines, singly placed and up to 0.5 mm. high, conical with rounded apex. The polyps attain a length of 2 mm., and have 10—14 rather vigorous tentacles placed in a single whorl below the oral portion. Spiralzooids are not traceable.

The gonophores are cryptomedusoid, placed, to a number of 3—6, round polyps almost wholly atrophied, forming, if anything, only a short stalk, or showing rudiments of tentacles slightly indicated.

Material:

The Kara Sea: Petuchoffskoi Schar depth 7 fath. (the original specimen described by Bergh 1887).

An examination of the original specimen, determined by Bergh, shows with full certainty that it is the same species that has afterwards been described by Bonnevie (1899) by the name of *Hydractinia minuta*. The diagnoses, however, when compared, will show some points of difference. Bonnevie does not mention the skeleton-formations at all while on the other hand, the statements of Bergh convey the impression of a greater resemblance to *Hydractinia echinata* than it really bears. *Hydractinia carica* lacks the small prickles found in the species last mentioned, and more vigorous spines also occur rather scarcely; the latter (Tab. I, Fig. 11) are smooth and more conically tapering than those of *Hydractinia Sarsi*. The main difference, however, between the diagnosis of Bonnevie and that of Bergh is implied in the mention of the blastostyles. Bergh states in his diagnosis "Sporosacs borne on very short, rudimentary hydrants, without or with very few (1—4) tentacles", while in the diagnosis of Bonnevie we find "Fixed gonophores without radial canals, from 3 to 5 in circle round the inconspicuous blastostyles", and in her short comment Bonnevie further states that the species is distinguished for "the complete atrophy of the gonophore-bearing hydranth". The specimens determined by Bergh show a great varying as to the development of the fertile polyp; it may, as he tells us, have 1—4 tentacles; but they are a great deal more reduced than is apparent from his pictures, and agree better with the drawings published by Jäderholm (1909, Pl. 2, Fig. 10—11). However,

there are in the colonies also numerous blastostyles, which are wholly devoid of rudiments of tentacles, and accordingly only forming a stalk in the same way as is indicated by the diagnosis of Bonnevie. But there always occurs a small polyp, and a "complete atrophy" of the polyp is in no case demonstrable; nor is it obvious from the imperfect figure of Bonnevie (1899, Tab. I, Fig. 3). — The great variation of the blastostyles of the original specimens determined by Bergh, shows us that the species stated by Bonnevie may be founded on a colony where the blastostyles carrying tentacles were reduced to a minimum in number. But this does not give sufficient reason for maintaining it as a peculiar species beside *Hydractinia carica*.

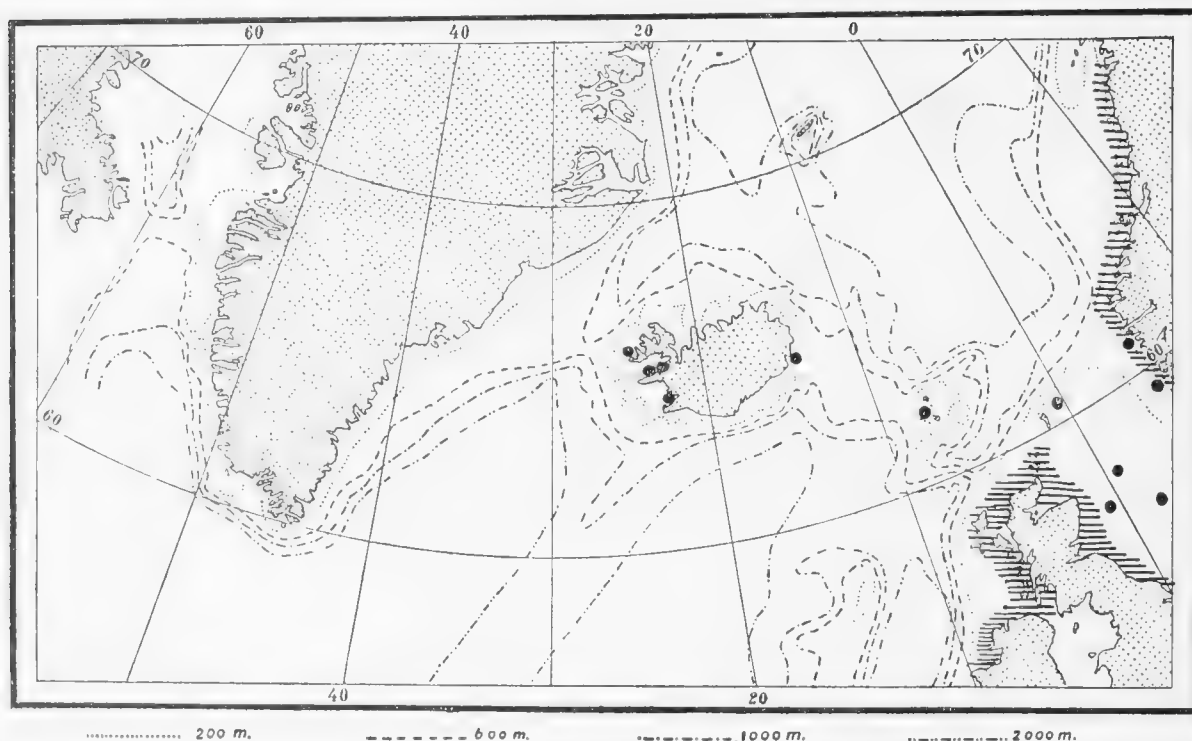
Hydractinia carica is an Arctic litoral species, which, in boreal waters, proves able to penetrate along the West coast of Norway as far as Bergen (Text-fig. M). It has been found elsewhere only in high arctic regions, in the Kara Sea, in the Murman Sea, and at Spitzbergen. It has also been recorded by Jäderholm (1909) from Davis Strait.

Gen. *Bougainvillia* Lesson.

Upright colonies with branched hydrocauli clothed with a perisarc. The polyps are fusiform with the tentacles placed in a whorl below the conically pointed oral portion. The polyps are naked without the slightest attempt at formation of pseudohydrotheca round their proximal portion. The gonophores are placed on the stems of polyps fully developed or reduced (blastostyles). In the latter case, the unbranched polyp stem will sometimes rise from the hydrorhiza instead of from the hydrocaulus.

A closer inquiry into the distinguishing characters and their systematic value, shows us that there is no reason to distribute the species of *Bougainvillia* on the three genera *Bougainvillia*, *Dicoryne*, and *Heterocordyle*. Sufficient cause for distinguishing between *Bougainvillia* and the two other genera is not at all given by the fact that the former has medusoid gonophores, while the two other genera have styloid gonophores. In mentioning the genera earlier treated, I have sufficiently explained the insignificance of this criterion as to classification. Then remains the other distinguishing mark that the gonophores of *Bougainvillia* develop on the stems of some fullgrown polyps, while in *Dicoryne* and *Heterocordyle* they are developed on the stems of reduced polyps (blastostyles). The genus *Hydractinia* shows us a full parallel to this condition of things. But because of the many and close connecting links between one extreme and the other, it has been agreed that the stronger and weaker specializing into nourishing polyps and blastostyles cannot be employed as a generic character. When, on the other hand, this has been done with *Bougainvillia* and *Dicoryne* and *Heterocordyle*, the only reason must be that, between the few species known of these genera, most of the links occurring in *Hydractinia* are wanting. This lack, in fact, is not a sufficient reason to elevate, in one case, the character to an importance which is denied in another case, even within the same family. It is not right to base the genera *Bougainvillia*, *Dicoryne* and *Heterocordyle* on characters that must be used with discretion as specific characters in *Hydractinia*. Further, as to the distinguishing mark between *Dicoryne* and *Heterocordyle*, it is still more diminutive. *Heterocordyle conybeiri* Allman, the only species known of the genus, is so like

Dicoryne conferta (Alder) as to confusion, and the two species have probably more than once been mistaken for one another. Both the species have styloid gonophores; but in *Heterocordyle* they are sessile, while in *Dicoryne*, when ripening, they assume cilia all over, develop two tentacles, and break away. This is, unquestionably, a phenomenon of mere biological adaptation and cannot be recognized as sufficient for distinction of genera as long as it is not accompanied by a thorough change of the organization of the sterile parts of the colony. It is evident that *Dicoryne* and *Heterocordyle* must be drawn together into one genus, and moreover that this genus must be united with *Bougainvillia*.



Text-fig. O. The habitat of *Bougainvillia conferta* in the Northern Atlantic.
(In the hatched regions the literature denotes the occurrence of the species without strict localities).

***Bougainvillia conferta* (Alder).**

1856 *Eudendrium confertum*, Alder, A Notice of Some New Genera and Species of British Hydroid Zoophytes, p. 354, pl. 12, fig. 5—8.

The colonies attain a height of up to 15 mm., and exhibit a rigid appearance. They have a distinct main stem with short side-branches. The perisarc is vigorously developed and dark brown-coloured. The small fusiform polyp attains a length of about 0.5 mm.; it wears about 16 tentacles in a single whorl below the oral conically pointed portion.

The gonophores are styloid and break away. When ripening, they assume a peculiar oviform shape, develop two filiform tentacles, and put on a complete suit of cilia all over. The gonophores are seated, gathered in a belt, somewhat below the apex of blastostyles, which arise from the hydrocaulus or, in smaller numbers, from the hydrorhiza. The blastostyles show no indication of tentacles.

Material:

Iceland: Talknafjord (without particular data).

Reydarfjord, depth 163 metres.

The Faroe Islands (without particular data).

Bougainvillia conferta is a southern-boreal species penetrating as far as into the Mediterranean; towards the north it goes, along the coast of Norway, only as far as Lofoten. It has been recorded several times from Iceland, in the warmer water-layers along the west- and south-coasts of the island, but it has not yet been pointed out at Greenland. As a new locality must be added the Faroe Islands. The species is indigenous to the litoral region.

Gen. *Perigonimus* M. Sars.

The hydranth stems rise immediately from the reptant stolons, or there are formed upright rhizocaulomes bearing the polyps. The polyp stems are sometimes divided into a couple of branches; still hydrocaulus, properly speaking, cannot be recorded. The polyps are fusiform, with the tentacles placed in a whorl below the conically pointed oral portion; below the tentacle whorl they are surrounded by delicate pseudohydrothecae, superiorly connected with the ectoderm of the hydranth, and inferiorly passing into the chitinous perisarc of the stem. The stinging cells show attempts at being arranged in transverse belts on the tentacles. The gonophores are placed singly on the stolons or on the hydranth stems, most frequently attached to the latter by a short stalk.

The distinguishing marks between *Perigonimus* and *Bougainvillia*, indeed, seem to be so insignificant that the conclusion might be obvious that both genera should be united into one. The *Perigonimus* polyp, when wholly extended, is very easily mistaken for a *Bougainvillia*. However, there is an essential difference between the two genera which necessitates a separation. Their medusae even belong to different families, the *Bougainvillia*-medusae being typical *Margelidae*, while *Perigonimus* gives rise to *Tiaridae* (see Hartlaub 1913). As far as the nurse polyp is concerned, we must notice the difference existing between the wholly naked *Bougainvillia*-polyp and the hydranth covered with pseudohydrotheca of the *Perigonimus*-polyp. The pseudohydrotheca has been pointed out by several authors and has been emphasized as generic character particularly by Broch (1911). A closer inquiry into this formation has been made by Hadži (1913, 1914), who has studied it most thoroughly in the Adriatic species, *Perigonimus Corii* Hadži and *Perigonimus Gcorginae* Hadži; the latter species is very nearly related to *Perigonimus repens* (Wright). Hadži points out that *Perigonimus* is provided with a sort of hydrotheca, the essential substance of which is jellied and accordingly not entirely parallel with the hydrotheca of the thecaphore hydroids. For this jellied polyp case, which is, in its outer margin, connected with the ectoderm of the polyp, I, therefore, employ the denomination of "pseudohydrotheca", earlier employed for the chitinous false hydrothecae of *Clathrozoön*. In the case of *Clathrozoön*, however, the formation seems to be quite different, and the denomination, on that account, rather misleading; indeed, we had better employ the term of "false hydrothecae". Hadži

calls our attention to the interesting fact that the polyps are basally attached to the pseudohydrotheca by a whorl of small chitinous bodies similar to that met with in *Haleciidae*, *Plumulariidae*, *Lafoëidae*, and *Campanulariidae*; they actually attach the supporting lamella to the polyp case. Systematically, however, hardly any particular importance can be attached to this character. The chitinous bodies occur on the passage from the pseudohydrotheca to the hard periderm of the stem. Also the periderm of the stem has, in most species of *Perigonimus* a jellied cover, to which a lot of foreign bodies fasten themselves so as to give the colony a foul appearance.

The stinging cells in the tentacles of the *Perigonimus*-species show attempts at an arrangement by belts. But it is not here so pronounced as in the *Eudendriidae* and the thecaphore hydroids. This criterion, together with the pseudohydrotheca, suggests that *Perigonimus* must be more nearly related to the thecaphore hydroids than most other athecate hydroids.

Perigonimus repens (Wright) Allman.

1857 *Eudendrium repens*, Wright, Observations on British Zoophytes, p. 84, pl. 82, fig. 8—9.

1864 *Perigonimus* —, Allman, On the Construction and Limitation of Genera among the Hydroida, p. 365.

nec 1911 — —, Broch, Fauna droebachiensis, p. 14.

From the reptant stolons proceed thin polyp stems, up to 5 mm. long, more rarely dichotomically divided so as to bear two polyps. The polyps are about 0.5 mm. long, broadly fusiform, with 4—12 tentacles placed in a whorl, and surrounded below the tentacles by a thin jellied pseudohydrotheca, which is sometimes hardly observable. The polyp stems are wholly without rings, and all but without wrinkles, and provided with a dark-coloured, but thin perisarc, which, on account of bottom particles appendant, convey the impression of being granulous.

The gonophores are developed into free medusae; when breaking away, they have two tentacles and a well-developed, solid umbrella. The gonophores are borne individually on stems 0.2—0.3 mm. long, proceeding from the hydranth stems; on one hydranth stem is generally developed one gonophore at a time, sometimes a couple of gonophores simultaneously.

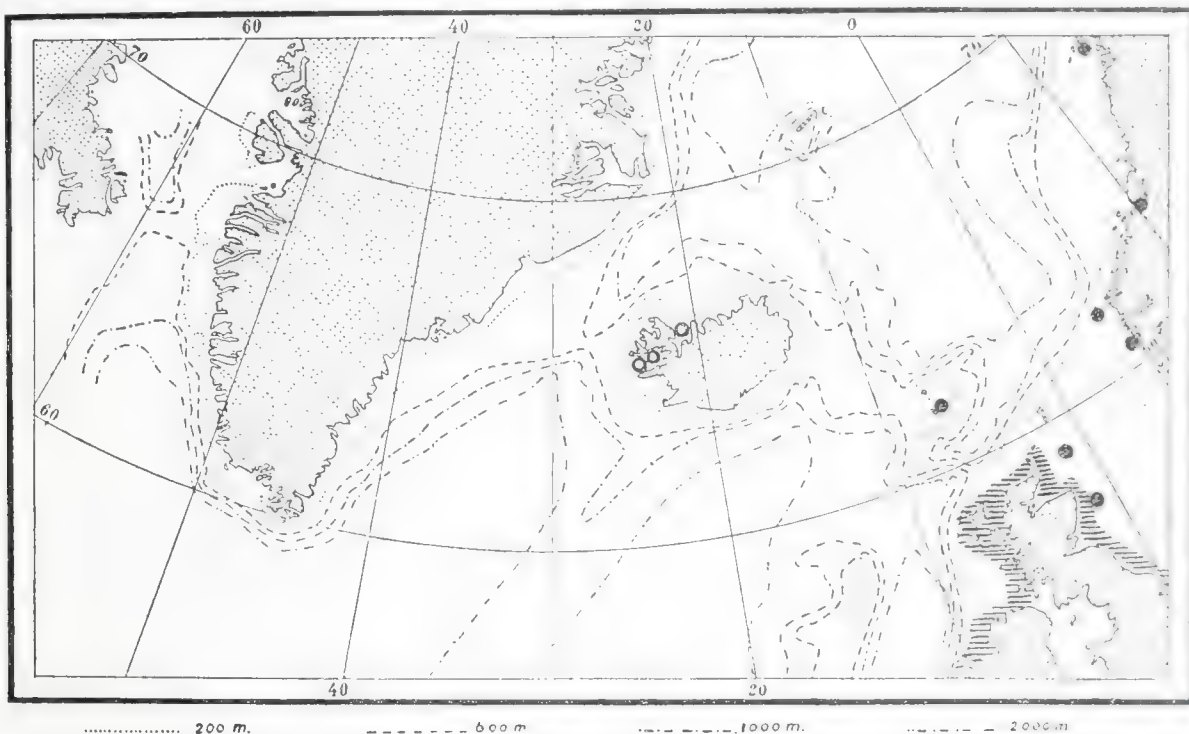
Material:

The Faroe Islands, Sörvaag. Depth 14—16½ fath. (on *Nucula nucleus*).

Certainly it is not this species that is delineated and described by the name of *Perigonimus repens* in Fauna Droebachiensis (Broch 1911). A comparison with the excellent drawings of the species with Jäderholm (1909, Taf. I, Fig. 15—16), at once shows us the difference. The species described and delineated from the Kristianiafjord has a stiff and robust structure; its perisarc is solid and the colonies are open rhizocaulome formations; most probably the specimens in question should have been referred to *Perigonimus muscoides* M. Sars. *Perigonimus repens*, on the other hand, has thin closely set, irregularly curved polyp stems. Besides, the colonies from the Kristianiafjord bear on the hydranth stems numerous gonophores without stalks, while the few gonophores of *Perigonimus repens* are borne on distinct small stalks covered with perisarc.

HYDROIDA

Perigonimus repens is a southern species which penetrates into our seas. It has been recorded from the Mediterranean and the west coast of France, and occurs frequently in the sea round Great Britain and Ireland. Already in the North Sea its occurrence is more straggling. In the Danish waters and along the coast of Bohuslän it is still rather frequent. On the coast of Norway it is not unfrequently met with in the Trondhjemfjord, where the fauna, on the whole, bears a southern character. But only once it has been found farther to the north, at Lofoten. Sæmundsson (1911) records several questionable specimens from the west and the north of Iceland. But these localities have to be confirmed. As a new locality must now be added the Faroe Islands. The species belongs to the litoral region.



Text-fig. P. The distribution of *Perigonimus repens* in the Northern Atlantic (o localities needing further confirmation. — In the hatched region the literature denotes a scattered although common occurrence of the species).

Perigonimus abyss G. O. Sars.

- 1874 *Perigonimus abyss*, G. O. Sars, Bidrag til Kundskaben om Norges Hydroider, p. 96, pl. 5, Fig. 27—30.
 1911 — sp., Kramp, Danmarks-Ekspeditionen til Grönlands Nordöstkyst, p. 363.

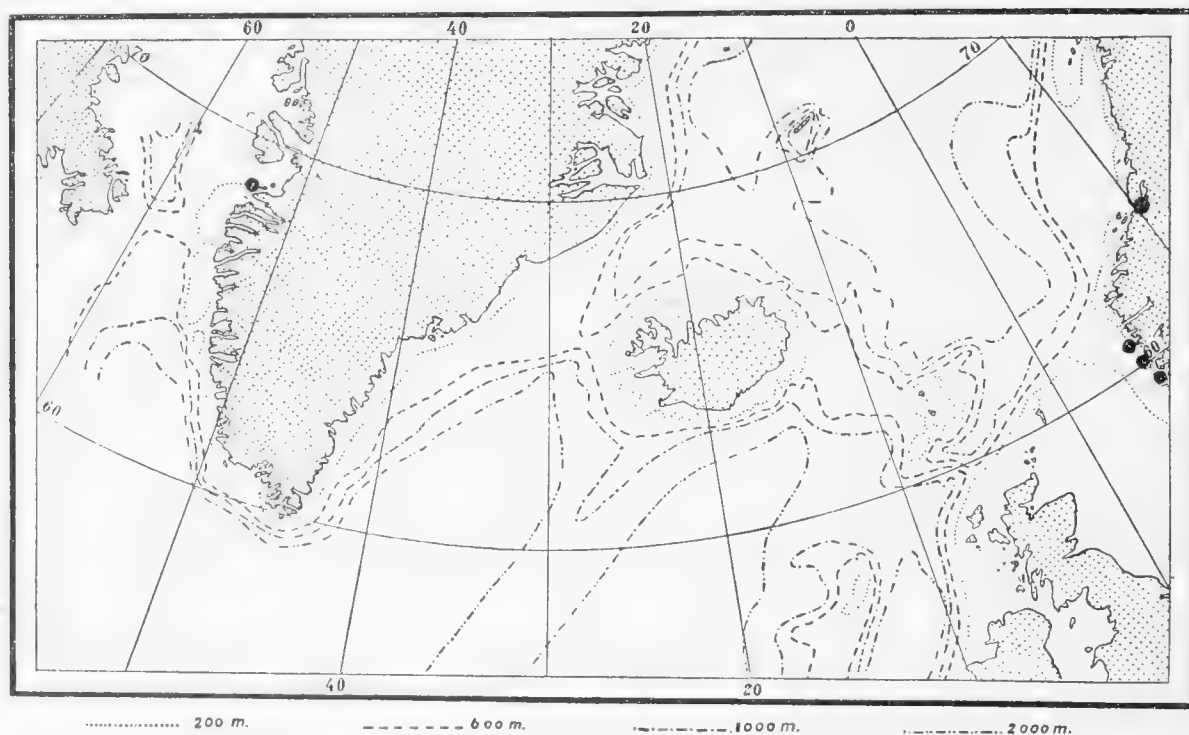
From the reptant stolons proceed unbranched polyp stems, which attain a length of 1.5 mm. The polyps are about 0.5 mm. long, broadly fusiform, bearing 5—8, usually 7 tentacles in a whorl. Below the tentacles the polyp is surrounded by a rather vigorous, wide, jellied pseudohydrotheca, which is, however, often hardly visible on the polyp wholly extended. The polyp stems are irregularly and strongly wrinkled, and have a dark-coloured, vigorous perisarc.

The gonophores are developed into free medusae, having, when deliberated, a vigorously developed umbrella and four tentacles. The gonophores are developed on the polyp stems, to which they are attached by a very short stalk. On the polyp stem arise one or two gonophores.

Material:

Greenland, Egedesminde (on *Lepeta cocca*).

The species has been found chiefly along the west coast of Scandinavia. It is likely to occur much more frequently than might be believed from the scattered data. On account of its small dimensions, and as, besides, it prefers settling on living, smaller molluscs, it too often escapes the attention of the investigators of hydroids. *Perigonimus abyssi* has been found at Bohuslän and on the west coast of Norway, from Stavanger as far as the Trondhjemsfjord, at the depth of 100—600 metres. On the north side of Beeren Island it has been met with at the depth of 165



Text-fig. Q. The finds of *Perigonimus abyssi* in the Northern Atlantic.

metres (Bonnievie 1899). In Arctic regions it may occur in considerably shallower waters. Thus the German expedition to Spitzbergen in 1898 found the species in the Storfjord at the depth of between 0 and 10 metres (Broch 1909), and certainly it is the same species that is recorded by Kramp (1911), by the name of *Perigonimus* sp., from the depth of 20—40 metres at a couple of stations of the "Danmark" Expedition. To the localities previously recorded must now also be added the west coast of Greenland near Egedesminde. — According to the data in hand, the species must be characterized as Arctic and boreal (Text-fig. Q).

***Perigonimus roseus* (M. Sars) Bonnievie.**

- 1874 *Rhizoragium roscum*, M. Sars in: G. O. Sars, Bidrag til Kundskaben om Norges Hydroider, p. 96.
 1892 *Garveia groenlandica*, Levinsen, Meduser, Ctenophorer og Hydroider fra Grönlands Vestkyst, p. 13.
 1898 *Perigonimus roseus*, Bonnievie, Neue norwegische Hydroiden.
 1911 *Garveia groenlandica*, Kramp, Danmark-Ekspeditionen til Grönlands Nordöstkyst, p. 363, pl. XXV, fig. 6.

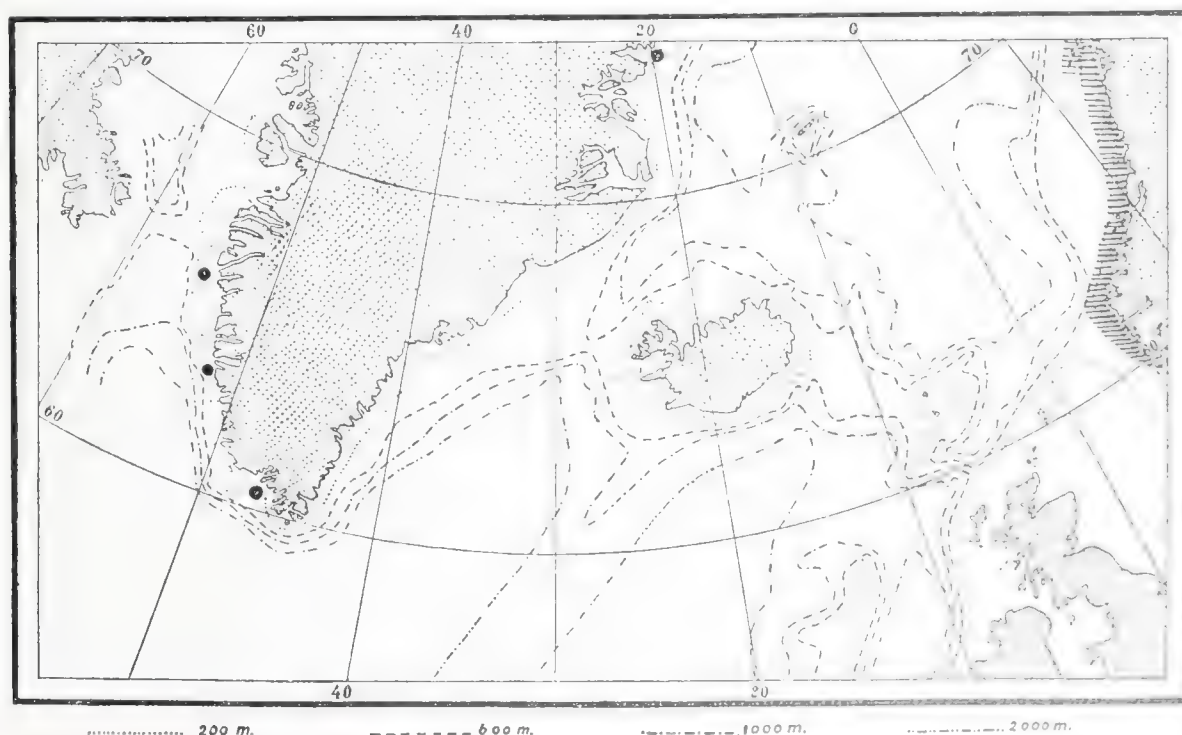
From the reptant stolons proceed polyp stems up to 12 mm. long, generally unbranched; more rarely 2—4 polyp stems proceed from a common trunk, 1—2 mm. high. The polyps attain a length of 0.7 mm., and are fusiform, with 6—12 tentacles placed in a whorl. Below the tentacles the polyp is surrounded by a pseudohydrotheca, which it is very difficult to observe on the polyp when wholly extended. In general it is jellied and vigorously developed. The polyp stems are, particularly in their proximal part, irregularly wrinkled.

The very large gonophores show no medusoid structure; they are attached to the reptant stolons by a short stem.

Material:

Greenland (Lille Hellefiskebanke) (the original specimen of *Garveia groenlandica* Levinsen).

An examination of the original specimen of *Garveia groenlandica* shows no difference at all from Norwegian specimens of *Perigonimus roseus*. The species are no doubt identical. If we compare Kramp's drawing of *Garveia groenlandica* (1911, pl. XXV, fig. 6) with Jäderholm's figure of *Perigonimus roseus* (1909, Taf. III, Fig. 7), there may, at the first glance, seem to be some points of difference. Thus the stems of the specimen mentioned by Kramp are much shorter. But this character proves of little significance if we compare the specimen with a larger colony, where, as a matter of fact, the length of the polyp stems varies greatly. A greater stress might, on the other hand, be laid on the apparently great difference between the pseudohydrothecae as represented in the two figures. However, much depends on the contraction of the polyps and on the state of preservation, as is plainly to be seen by an inquiry into a larger material. I have several times had the opportunity of observ-



Text-fig. R. The occurrence of *Perigonimus roseus* in the Northern Atlantic.
(In the hatched region the occurrence according to the literature is common although scattered).

ing, in larger colonies of *Perigonimus*, individuals with pseudohydrothecae bulging even more loosely round the shrunken and contracted polyps than that rendered in Kramp's drawing, while, at the same time, in extended polyps in the same colony, a superficial view fails to notice the presence of this formation (Broch 1911, fig. 12). The intermediate state represented by Jäderholm is the commonest observed in preserved colonies. Still one point of difference might seem to remain, the chitinous cup in which the gonophore, in *Garveia groenlandica*, is resting when it is about to empty its ripe contents. This cup, or rather this remnant of the flayed-off external periderm cover of the gonophore, is, however, frequently observed also in the female gonophores of typical *Perigonimus roseus*, in which hitherto no particular importance has been attached to this character. Accordingly, we have to include *Garveia groenlandica* as a synonyme under *Perigonimus roseus*.

The chief occurrence of the species is attached to the middle and the lower parts of the litoral region of the boreal waters. It occurs rather frequently from Bohuslän as far as Lofoten, generally attached to stalks of *Tubularia indivisa*. However the species also penetrates far into Arctic waters, and has been recorded from the White Sea and as far to the north as Nova Zembla. It has previously been recorded from Greenland (Jäderholm 1909), where now also Lille Hellefiskebanke, Fiske-nes (West Greenland), and Danmarks Havn (East Greenland) have to be added to its localities (Text-fig. R).

Family Eudendriidae.

Hydroids forming colonies, the polyps of which are provided with a single whorl of filiform tentacles. The proboscis is capitate, placed with a narrow base on the broad polyp body above the tentacle whorl; the stinging cells of the tentacles are small and rodshaped. Also larger stinging cells, narrowly oval, occur, particularly in the specific stinging organs of the polyp. The stinging cells of the tentacles are arranged in very distinctive transverse belts. The polyps are wholly naked. The endoderm of the polyp is differentiated into two portions, an oral portion, consisting of small-nucleated, indifferent cells, among which occur some mucous gland cells, and the proper gastral portion. The limit is formed by the tentacle whorl. The tentacles lack a central cavity. The colonies have no calcareous skeleton.

Nearly all investigators of hydroids have distinguished the *Eudendriidae* as a family of their own. To this Levinsen (1892) forms an exception, considering the arrangement of the tentacles in a single whorl round the polyp as indicative of so near a relationship to the *Bougainvilliidae* that he unites the two families into one. However, the *Eudendriidae*, in their structure of the polyps, show, as compared to other athecate hydroids, such peculiarities that we are forced to distinguish them as a family of their own. In the first place are obvious the broad structure of the polyp body and the capitate proboscis, placed with a narrow base above the well defined tentacle portion. In this character the polyps bear a strongly marked resemblance to the thecaphore *Campanulariidae*. This likeness is the more interesting because, in the more delicate structure of the polyp of the *Eudendriidae*, several points of resemblance to the thecaphore hydroids are demonstrable. Thus the stinging cells of the tentacles of *Eudendriidae*, as well as those of the thecaphore hydroids, are arranged in well defined

transverse belts. This peculiarity we find slightly indicated even in some *Bougainvilliidae*. But only in the *Eudendriidae* it has become a character plainly distinctive. Further, the endoderm in the well defined hypostome shows the same structure as in the thecaphore hydroids, and is more strongly differentiated than in the *Bougainvilliidae*, the indifferent cells having gained the ascendancy, and the number of the mucous gland cells having been reduced to a minimum. Whether these peculiarities are indicative of a nearer relationship between the *Eudendriidae* and the thecaphore hydroids, is a question which it would here be out of place to enlarge upon.

The *Eudendriidae*, with their frequently dimorphic development of the stinging cells, also present a parallel to the *Stylasteridae*. Besides the small rodformed stinging cells characteristic of all *Filifera*, we also find in several species larger narrowly oval ones, bearing a strong resemblance to those of the *Stylasteridae*. The latter are large, but of the same shape as the small stinging cells of *Myriothele*. We probably here face a phenomenon of convergency, the reason of which, however, at the present stage of our knowledge of the biology of the Coelenterata, we cannot account for with any certainty. Wherever the larger stinging cells occur in the *Eudendriidae* they are accumulated in particular stinging organs.

Eudendrium Ehrenberg.

Upright colonies with branched hydrocaulus. The polyps are broad and distinctly set off from the stem, which is covered with a vigorous chitinous perisarc. The polyp has a single whorl of filiform tentacles. Above the tentacle whorl the polyp is suddenly tapering and ends into a capitate or trumpetshaped proboscis, which is seated, with a narrow base, above the tentacle whorl. The gonophores are developed on normal or reduced polyps, or placed singly on the branches.

Kühn (1913, p. 48) states that the polyp tentacles of *Eudendrium* "nach einander vorsprossen und dadurch sich als Angehörige verschiedener Wirtel zu erkennen geben". Later on (l. c. p. 247) he again mentions this peculiarity as a refutatory argument against the adoption of a nearer relationship to the thecaphore hydroids; in the passage last quoted he apparently bases his opinion essentially on Allman (1872). A closer inquiry, on new material, gave no hold to the statement of Allman and Kühn that the tentacles should appear successively. In the numerous colonies examined of *Eudendrium rameum* (Pallas) and *Eudendrium Wrighti* Hartlaub it could be ascertained that all the tentacles appear simultaneously. This suggests that the observations of Allman may rather depend on accidental circumstances, and that no special importance must be attached to them as reminiscences of manyrowed tentacle-whorls of the ancestors or as proofs of a nearer or remoter relationship to the *Bougainvilliidae* or to the thecaphore hydroids.

Eudendrium rameum (Pallas) Thompson.

1766 *Tubularia ramca*, Pallas, Elenchus zoophytorum, p. 83.

1844 *Eudendrium rameum*, Thompson, Report on the Fauna of Ireland, p. 283.

1887 — *ramosum*, Bergh, Karahavets goplepolyper, p. 332.

- 1908 *Eudendrium caricum*, Jäderholm, Die Hydroiden des Sibirischen Eismeer, p. 5, Taf. I, Fig. 4, Taf. II, Fig. 1.
 1911 — *rigidum?* + *Eudendrium ramosum*, Sæmundsson, Bidrag til Kundskaben om de islandske Hydroider, p. 74—75.

The strongly and irregularly branched colonies have a fascicled main stem, and attain a height of 200 mm. The small branches are annulated immediately above their rise from the mother branch, but are elsewhere smooth. The polyps have about 20 tentacles. There is no particularly developed ring of stinging cells round the tentacles or the polyp body. The colonies have no particular stinging organs.

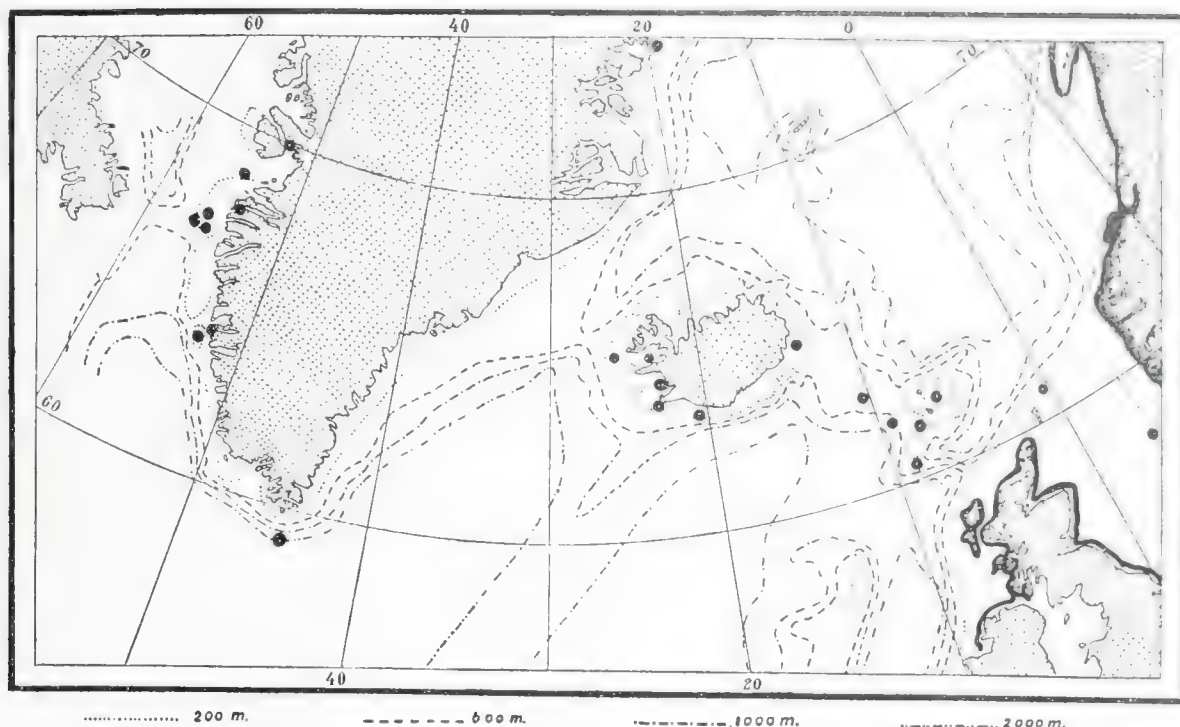
The gonophores are styloid. The male gonophores have 2—4 chambers and are seated round the base of fully developed polyps. The female gonophores are pear-shaped, and are borne on the bodies or the hydrocauli of polyps that may either be fully developed, or somewhat smaller than the sterile polyps, or entirely reduced. The spadix is unbranched.

Material:

"Ingolf" St. 21.	58°01' N. lat.	44°45' long W.	Depth 1330 fath.	2°4 C.
— - 31.	66°35' - -	55°54' — -	88 —	1°6 -
— - 44.	61°42' - -	9°36' — -	545	4°8 -
Greenland: Davis Strait	Depth 80—100 fath.			
Henry Land, East Greenland	— 20 —			
Cape Tobin	— 57 —			
Iceland: 6 miles west of Iceland	— 22 —			
Stykkisholm	— 20—30 —			
Faxebugt, 16 miles N.E. of Akranes (" <i>Eudendrium ramosum</i> ")	— 26—30 —			
Vestman Islands (" <i>Eudendrium rigidum?</i> ")	— 30 —			
The Faroe Islands: Stokken 2 engl. miles S 22 E.	— 55 —			
"Thor"	61°15' N. lat.	9°35' W. long.	—	872 m.
"Diana"	61°40' - -	7°40' - -	—	135 fath.
Store Riskebanke (Large fishing-bank) 57°7' - -	2°40' E.	—	—	37 —
The Kara Sea, "Djimpha".				

This common northern species has, no doubt, frequently been confused with the southern species *Eudendrium ramosum* (Lin.), which, in fact, is rather rare in our northern seas. Assuredly enough, nearly all the statements of the occurrence of the last-mentioned species in Arctic waters, are to be regarded as referring to specimens of *Eudendrium ramosum*, the appearance of which varies greatly indeed. It has already been pointed out by Kramp (1911) that the species *Eudendrium caricum* from the Russian polar expedition, described by Jäderholm (1908), is, in fact, founded on specimens of *Eudendrium ramosum*. Surely enough, it is the same species which is recorded by Bergh (1887) now as *Eudendrium ramosum* and *Eudendrium ramosum*, now as *Eudendrium* sp.

The species has a circumpolar distribution, and appears, from the statements of literature, to be a



Text-fig. S. The habitat of *Eudendrium ramosum* in the Northern Atlantic.

perfect cosmopolite. It occurs frequently everywhere in the middle and deeper parts of the litoral region of the northern seas (Text-fig. S), and may, exceptionally, as in the "Ingolf" st. 21, also penetrate far down into the abyssal region.

Eudendrium ramosum (Linné) Ehrenberg.

1758 *Tubularia ramosa*, Linné, Systema naturæ, ed. X, p. 804.

1834 *Eudendrium ramosum*, Ehrenberg, Beiträge zur physiologischen Kenntniss der Corallenthiere, p. 296.

nec 1887 — — , Bergh, Karahavets Goplepolyer, p. 332.

nec 1911 — — , Sæmundsson, Bidrag til Kundskaben om de islandske Hydroider, p. 74.

The strongly branched colonies show an almost quite regular, alternating arrangement of the small branches. The main stem is fascicled. The small branches are annulated above their rise from the mother branch, but are elsewhere quite smooth. The polyps have about 20 tentacles. The stinging cells are not accumulated in any particular main ring round the tentacles or the polyp body. The colony has no particular stinging organs.

The gonophores are styloid. The male gonophores have 2—3 chambers and are seated entirely atrophied polyps with short hydrocauli. The female gonophores are pear-shaped and seated on the bodies or on the stems of polyps which are either fully developed or somewhat reduced compared to the sterile polyps. The spadix is unbranched.

Material:

Southeastern Iceland: (Hörring) 1898. — Depth 52—49 fath.

The species *Eudendrium ramosum* (Pallas), *Eudendrium rameum* (Pallas), and *Eudendrium racemosum* (Cavolini) are very nearly related to each other, and sterile colonies of the three species are often hardly distinguished with certainty. While in *Eudendrium rameum* the male gonophores are borne on polyps fully developed, they are seated, in *Eudendrium ramosum* and *Eudendrium racemosum* round polyps wholly reduced. This conformity of the two last-mentioned species, the homogeneous structure of their colonies, and several other features common to them, which struck me during my inquiry into the Adriatic hydroids (1912), really led me to consider, though with some doubt, *Eudendrium racemosum* as a synonyme of *Eudendrium ramosum*. This supposition, however, is hardly right. By the liberality of Dr. C. Lehnhöfer at Innsbruck I have afterwards had the opportunity of examining more closely unquestionable colonies of *Eudendrium racemosum* from Trieste, and of recognizing in these the characteristic criteria distinguishing this species from *Eudendrium ramosum*. Occasionally are found developed in the polyp of *Eudendrium racemosum* peculiar organs which are not traceable in other species of the genus, and which, like analogous organs in other hydroids, have to be designated as "nematophores" (cp. Weismann 1882). Elsewhere the presence or the absence of these formations is looked upon as a generic character among the hydroids. But this view is here hardly justifiable, as in *Eudendrium racemosum* the nematophores occur quite irregularly and are rather rare; in some colonies they are even entirely wanting, and such colonies, when sterile, or when only male individuals occur, cannot be distinguished with certainty from *Eudendrium ramosum*. — The other distinguishing mark between the two species is the spadix of the female gonophores. While, according to the descriptions in hand, the spadix of *Eudendrium ramosum* is unbranched, that of *Eudendrium racemosum* is, on the contrary, bifurcate or divided into three branches, embracing the ovum like a claw (s. Broch 1914 Stylasteridae p. 24, Text-fig. I) I regret that I have not succeeded in getting hold of fertile female colonies of *Eudendrium ramosum*, so as to be unable to give a drawing, from new material, of the female gonophore of this species.

From the statements above it is clear that *Eudendrium ramosum* has most probably been several times confused with *Eudendrium racemosum*. On the other hand, as I have earlier pointed out, a confusion with *Eudendrium rameum*, particularly from the northern seas has also often taken place, and the geographical data presently in hand as to *Eudendrium ramosum* are, therefore, of most questionable value. A closer inquiry into the colonies from Faxebugt (Iceland) recorded by Sæmundsson (1911) as *Eudendrium ramosum*, shows that we here really face typical *Eudendrium rameum*. However, the single specimen of the species which is in hand, shows us that in warmer layers of the Atlantic it may occur as far to the north as Iceland. The occurrence of the species in the northern Atlantic regions, however, has yet to be more closely accounted for.

Eudendrium Wrighti Hartlaub.

1859 *Eudendrium arbuscula*, Wright, Observations on British Zoophytes, p. 113, pl. 9, fig. 5—6.

1905 — *Wrighti*, Hartlaub, Die Hydroiden der magalhaensischen Region, p. 547.

The strongly and irregularly branched colonies have a fascicled main stem, and attain a height of 60 mm. The small branches are annulated above their rise from the mother branch, but are elsewhere smooth. The polyps have a large number of tentacles. The tentacles have no particularly

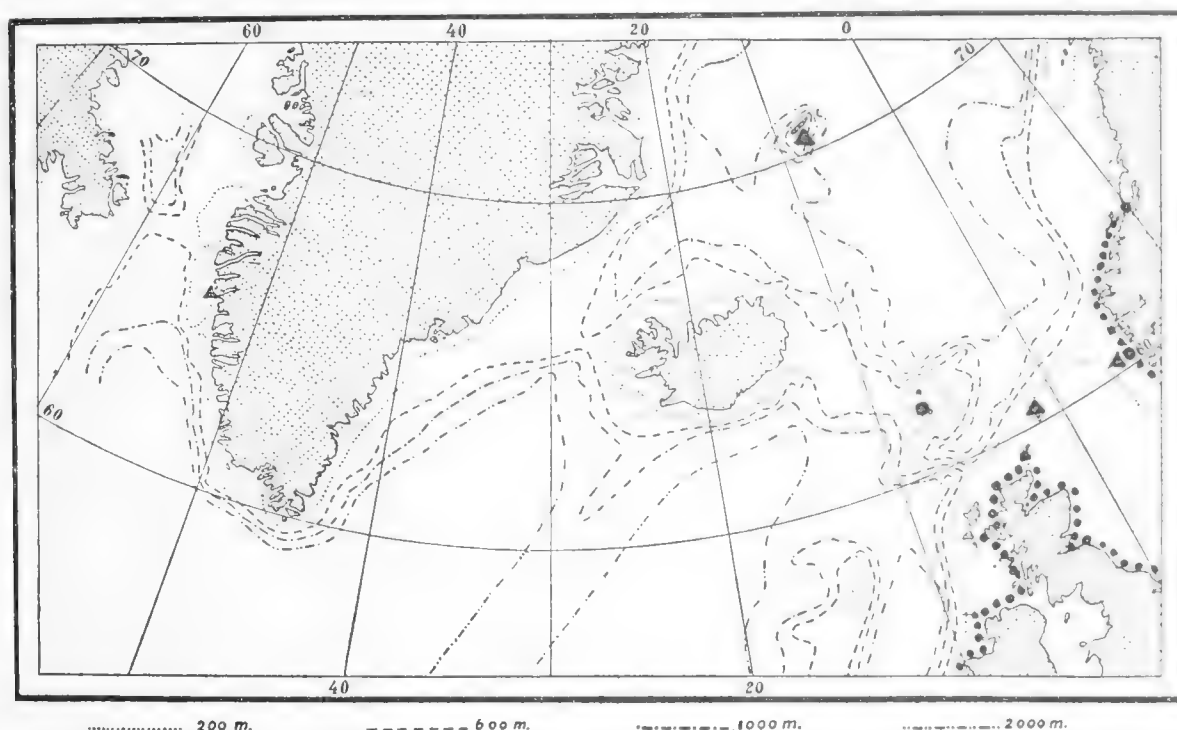
distinct main ring of nematocysts. On the other hand, there is round the polyp body, at its base, a distinctive girdle of large stinging cells. Otherwise, the colony has no particular stinging organs.

The gonophores are styloid. The male gonophores have two chambers with a well marked accumulation of stinging cells distally, and are densely clustered on short stems perpendicularly placed on the trunk. Female gonophores are unknown.

Material:

The Faroe Islands: Trangisvaag, on roots of *Laminaria*.

The species was first described by Wright (1859) by the name of *Eudendrium arbuscula* from the Firth of Forth. However, another *Eudendrium* had been previously described by d'Orbigny



Text-fig. T. The occurrence of *Eudendrium Wrighti* ● and *Eudendrium annulatum* ▲ in the Northern Atlantic. (The dotted coastal parties denote a scattered occurrence of *Eudendrium Wrighti* according to the literature).

(1839) by the name of *Tubularia arbuscula* from Patagonia, and even though it will be questionable whether the species of d'Orbigny can be reidentified, we are no doubt right to follow Hartlaub (1905) and abandon the name of *arbuscula* for the northern species. Here we, therefore, adopt the denomination of Hartlaub, *Eudendrium Wrighti*.

Eudendrium Wrighti is an absolutely littoral species, the occurrence of which seems to be restricted to the zone of the *Laminaria*. It occurs quite frequently from Bohuslän as far as towards the Trondhjemfjord, and it is peculiar, therefore, that its female gonophores have not yet been pointed out. The species is quite common at the British Isles (s. the Text-fig. T), and it has also been recorded from the Mediterranean. *Eudendrium Wrighti* is, therefore, likely to be characterized as an Atlantic species of southern character, which is able to penetrate into the northern seas as far as the Trondhjemfjord. The Faroe Islands have now to be added to the localities where the species has been found.

Eudendrium annulatum Normann.

1864 *Eudendrium annulatum*, Norman, On undescribed British Hydrozoa, Actinozoa, and Polyzoa, p. 83, pl. 9, fig. 1—3.

The strongly and irregularly branched colonies have a fascicled main stem, and attain a height of 100 mm. All the smaller branches are densely annulated everywhere. The polyps have 16—20 tentacles. There are no particular accumulations of stinging cells on the tentacles or on the polyp body, and the colony has no particular stinging organs.

The gonophores are styloid. The male gonophores have one chamber with an accumulation of stinging cells distally, and are densely grouped on short stalks perpendicularly placed on the stem. The female gonophores have an unbranched spadix and form grape-like clusters round polyps entirely atrophied.

Material:

Greenland: Sukkertoppen (without particular data).

Iceland: Vestman Island, on the stems of *Tubularia indivisa*.

Eudendrium annulatum seems to occur rather sparsely, but apparently on the whole prefers the littoral parts of the boreal seas. However, among the localities of the species are also recorded the Cape Verde Islands (Quelch 1885), and with some doubt Cape Town (Ritchie 1907). On the west coasts of Scandinavia the species has been met with here and there from Bohuslän as far as Vadsö, and it even occurs in the Murman Sea. It has been found near Jan Mayen and the Shetlands, and specimens occur from the south of Iceland and from West Greenland.

Eudendrium capillare Alder.

1856 *Eudendrium capillare*, Alder, A notice of some new Genera and Species of British Hydroid Zoophytes, p. 355, pl. 12, fig. 9—12.

The strongly and irregularly branched colonies have a simple unfascicled main stem, and attain a height of 30 mm. The branches show a few rings immediately above their rise. But elsewhere they are smooth. The polyps have 20—30 tentacles. There are no particular accumulations of stinging cells on the tentacles or on the polyps. The colonies have no particular stinging organs.

The gonophores are styloid. The male gonophores have two chambers with an accumulation of stinging cells distally, and are placed in a whorl round entirely atrophied polyps or, more rarely, round strongly reduced polyps, the stems of which rise from the hydrocaulus or the hydrorhiza. The female gonophores occur in the same manner; they are pear-shaped with unbranched spadix.

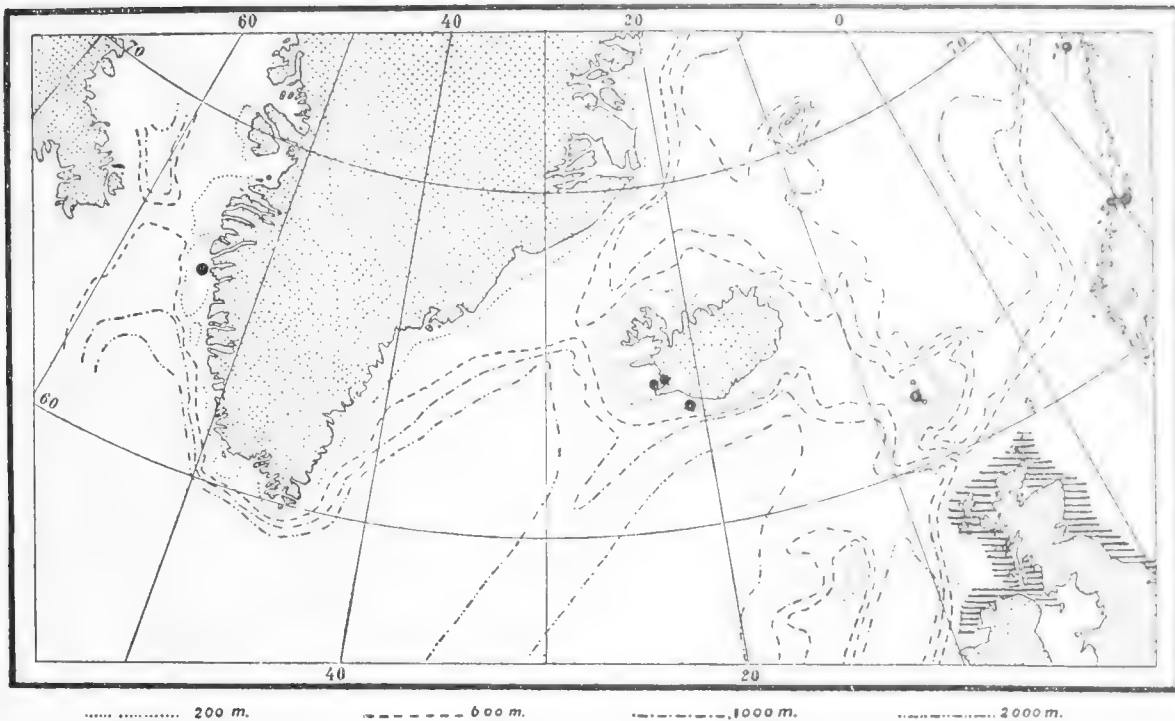
Material:

Greenland: Store Hellefiskebanke . . . Depth 28 fath.

Iceland: Stykkisholm . . . Depth 30 fath.

The Faroe Islands: between Nolsö and Østnæs . . . Depth 100 fath.

The specimens from the "Store Hellefiskebanke" offer a great interest, the male gonophores



Text-fig. U. The distribution of *Eudendrium capillare* in the Northern Atlantic.
 (The hatched coastal region indicates a scattered occurrence according to the literature).

being borne by diminutive polyps. It accordingly appears that the fertile polyps of the species are not always wholly atrophied, as has hitherto been generally supposed.

The distribution of *Eudendrium capillare* is extremely wide, almost quite cosmopolitan. It very frequently occurs in the northern seas (Text-fig. U); however, already in the Norwegian Sea and along the west coast of Norway its occurrence becomes less frequent, and it does not penetrate very far into the Arctic regions. The species belongs to the middle parts of the littoral region.

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Plate I.

Plate I.

- Fig. 1. Nematocyst from the tentacle of *Monocoryne gigantea*. Delafields haematoxyline — Iron ammonium sulfate. $1750/1$.
- 2. Nematocyst from the tentacle of *Coryne Lovéni*. Boehmers haematoxyline — Iron ammonium sulfate. $1750/1$.
- 3. Nematocysts from the tentacle of *Myriothela phrygia*, a: of the general, ovoid type, b: of the rarer, narrow type. Delafields haematoxyline — Iron ammonium sulfate. $1750/1$.
- 4. Nematocyst from the tentacle of *Tubularia indivisa*. Delafields haematoxyline — van Giesson. $1750/1$.
5. Nematocyst from the tentacle of *Clava multicornis*. Delafields haematoxyline — Iron ammonium sulfate. $1750/1$.
- 6. Nematocyst from the tentacle of *Bougainvillia ramosa*. Delafields haematoxyline — Iron ammonium sulfate. $1750/1$.
- 7. Nematocysts from *Eudendrium Wrighti*, a: small type from the tentacles, b: larger type from the belt of stinging cells at the base of the polyp body. Delafields haematoxyline — Iron ammonium sulfate. $1750/1$.
- 8. *Myriothela phrygia*; mutilated specimen from the "Ingolf" st. 125. $2/1$.
- 9. *Hydractinia cchinata*; spines from the Greenland specimen. $60/1$.
- 10. — — specimen from Greenland with extraordinarily large spines. $2/1$.
- 11. *Hydractinia carica*; spines from the type specimen. $60/1$.
- 12. *Hydractinia Sarsii*; spines from a specimen from Godthaab harbour, wrongly labelled "*Podocoryne carnea*". $60/1$.



9



6



2



7a



7b



10



3a



3b



11



4



12

Plate II.

Plate II.

- Fig. 13. *Coryne Loveni*; specimen from Bjarköy, Northern Norway. $20/1$.
- 14. *Corymorpha groenlandica*; one of Allmans type specimens of *Monocaulus groenlandica* showing the young blastostyles as mere sacs without any trace of the single gonophores. $30/1$.
- 15. *Corymorpha groenlandica* from the Davis street, wrongly labelled "*Amalthæa islandica*". Nat. size.
16. *Tubularia pulcher*. Gonophore of one of the type specimens of "*Auliscus pulcher*". $60/1$.
17. *Merona cornucopiæ* on *Cardium* sp. from the Faroe-islands. $30/1$.



THE INGOLF-EXPEDITION

1895—1896.

THE LOCALITIES, DEPTHS, AND BOTTOMTEMPERATURES OF THE STATIONS

Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom- temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom- temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom- temp.
1	62° 30'	8° 21'	132	7°2	24	63° 06'	56° 00'	1199	2°4	45	61° 32	9° 43'	643	4°17
2	63° 04'	9° 22'	262	5°3	25	63° 30'	54° 25'	582	3°3	46	61° 32'	11° 36'	720	2°40
3	63° 35'	10° 24'	272	0°5		63° 51'	53° 03'	136		47	61° 32'	13° 40'	950	3°23
4	64° 07'	11° 12'	237	2°5	26	63° 57'	52° 41'	34	0°6	48	61° 32'	15° 11'	1150	3°17
5	64° 40'	12° 09'	155			64° 37'	54° 24'	109		49	62° 07'	15° 07'	1120	2°91
6	63° 43'	14° 34'	90	7°0	27	64° 54'	55° 10'	393	3°8	50	62° 43'	15° 07'	1020	3°13
7	63° 13'	15° 41'	600	4°5	28	65° 14'	55° 42'	420	3°5	51	64° 15'	14° 22'	68	7°32
8	63° 56'	24° 40'	136	6°0	29	65° 34'	54° 31'	68	0°2	52	63° 57'	13° 32'	420	7°87
9	64° 18'	27° 00'	295	5°8	30	66° 50'	54° 28'	22	1°05	53	63° 15'	15° 07'	795	3°08
10	64° 24'	28° 50'	788	3°5	31	66° 35'	55° 54'	88	1°6	54	63° 08'	15° 40'	691	3°9
11	64° 34'	31° 12'	1300	1°6	32	66° 35'	56° 38'	318	3°9	55	63° 33'	15° 02'	316	5°9
12	64° 38'	32° 37'	1040	0°3	33	67° 57'	55° 30'	35	0°8	56	64° 00'	15° 09'	68	7°57
13	64° 47'	34° 33'	622	3°0	34	65° 17'	54° 17'	55		57	63° 37'	13° 02'	350	3°4
14	64° 45'	35° 05'	176	4°4	35	65° 16'	55° 05'	362	3°6	58	64° 25'	12° 09'	211	0°8
15	66° 18'	25° 59'	330	—0°75	36	61° 50'	56° 21'	1435	1°5	59	65° 00'	11° 16'	310	0°1
16	65° 43'	26° 58'	250	6°1	37	60° 17'	54° 05'	1715	1°4	60	65° 09'	12° 27'	124	0°9
17	62° 49'	26° 55'	745	3°4	38	59° 12'	51° 05'	1870	1°3	61	65° 03'	13° 06'	55	0°4
18	61° 44'	30° 29'	1135	3°0	39	62° 00'	22° 38'	865	2°9	62	63° 18'	19° 12'	72	7°92
19	60° 29'	34° 14'	1566	2°4	40	62° 00'	21° 36'	845	3°3	63	62° 40'	19° 05'	800	4°0
20	58° 20'	40° 48'	1695	1°5	41	61° 39'	17° 10	1245	2°0	64	62° 06'	19° 00'	1041	3°1
21	58° 01'	44° 45'	1330	2°4	42	61° 41'	10° 17'	625	0°4	65	61° 33'	19° 00'	1089	3°0
22	58° 10'	48° 25'	1845	1°4	43	61° 42'	10° 11'	645	0°05	66	61° 33'	20° 43'	1128	3°3
23	60° 43'	56° 00'	Only the Plankton-Net used		44	61° 42'	9° 36'	545	4°8	67	61° 30'	22° 30'	975	3°0

Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom- temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom- temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom- temp.
68	62° 06'	22° 30'	843	3°4	92	64° 44'	32° 52'	976	1°4	118	68° 27'	8° 20'	1060	—1°0
69	62° 40'	22° 17'	589	3°9	93	64° 24'	35° 14'	767	1°46	119	67° 53'	10° 19'	1010	—1°0
70	63° 09'	22° 05'	134	7°0	94	64° 56'	36° 19'	204	4°1	120	67° 29'	11° 32'	885	—1°0
71	63° 46'	22° 03'	46			65° 31'	30° 45'	213		121	66° 59'	13° 11'	529	—0°7
72	63° 12'	23° 04'	197	6°7	95	65° 14'	30° 39'	752	2°1	122	66° 42'	14° 44'	115	1°8
73	62° 58'	23° 28'	486	5°5	96	65° 24'	29° 00'	735	1°2	123	66° 52'	15° 40'	145	2°0
74	62° 17'	24° 36'	695	4°2	97	65° 28'	27° 39'	450	5°5	124	67° 40'	15° 40'	495	—0°6
	61° 57'	25° 35'	761		98	65° 38'	26° 27'	138	5°9	125	68° 08'	16° 02'	729	—0°8
	61° 28'	25° 06'	829		99	66° 13'	25° 53'	187	6°1	126	67° 19'	15° 52'	293	—0°5
75	61° 28'	26° 25'	780	4°3	100	66° 23'	14° 02'	59	0°4	127	66° 33'	20° 05'	44	5°6
76	60° 50'	26° 50'	806	4°1	101	66° 23'	12° 05'	537	—0°7	128	66° 50'	20° 02'	194	0°6
77	60° 10'	26° 59'	951	3°6	102	66° 23'	10° 26'	750	—0°9	129	66° 35'	23° 47'	117	6°5
78	60° 37'	27° 52'	799	4°5	103	66° 23'	8° 52'	579	—0°6	130	63° 00'	20° 40'	338	6°55
79	60° 52'	28° 58'	653	4°4	104	66° 23'	7° 25'	957	—1°1	131	63° 00'	19° 09'	698	4°7
80	61° 02'	29° 32'	935	4°0	105	65° 34'	7° 31'	762	—0°8	132	63° 00'	17° 04'	747	4°6
81	61° 44'	27° 00'	485	6°1	106	65° 34'	8° 54'	447	—0°6	133	63° 14'	11° 24'	230	2°2
82	61° 55'	27° 28'	824	4°1		65° 29'	8° 40'	466		134	62° 34'	10° 26'	299	4°1
83	62° 25'	28° 30'	912	3°5	107	65° 33'	10° 28'	492	—0°3	135	62° 48'	9° 48'	270	0°4
	62° 36'	26° 01'	472		108	65° 30'	12° 00'	97	1°1	136	63° 01'	9° 11'	256	4°8
	62° 36'	25° 30'	401		109	65° 29'	13° 25'	38	1°5	137	63° 14'	8° 31'	297	—0°6
84	62° 58'	25° 24'	633	4°8	110	66° 44'	11° 33'	781	—0°8	138	63° 26'	7° 56'	471	—0°6
85	63° 21'	25° 21'	170		111	67° 14'	8° 48'	860	—0°9	139	63° 36'	7° 30'	702	—0°6
86	65° 03'6	23° 47'6	76		112	67° 57'	6° 44'	1267	—1°1	140	63° 29'	6° 57'	780	—0°9
87	65° 02'3	23° 56'2	110		113	69° 31'	7° 06'	1309	—1°0	141	63° 22'	6° 58'	679	—0°6
88	64° 58'	24° 25'	76	6°9	114	70° 36'	7° 29'	773	—1°0	142	63° 07'	7° 05'	587	—0°6
89	64° 45'	27° 20'	310	8°4	115	70° 50'	8° 29'	86	0°1	143	62° 58'	7° 09'	388	—0°4
90	64° 45'	29° 06'	568	4°4	116	70° 05'	8° 26'	371	—0°4	144	62° 49'	7° 12'	276	1°6
91	64° 44'	31° 00'	1236	3°1	117	69° 13'	8° 23'	1003	—1°0					





THE DANISH INGOLF-EXPEDITION.

VOLUME V.

7.

HYDROIDA.

(PART II.)

BY

HJALMAR BROCH.

WITH 1 PLATE AND 95 FIGURES IN TEXT.



1965-43
11: 6: 25

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I. Comparative anatomy of the nourishing individuals, and systematic division of the thecaphore hydroids.

As with the athecate hydroids, so also in the case of the thecaphores, the comparative anatomy of the nourishing individuals affords us a certain working basis in systematical respects. With regard to this group, however, the investigations are still somewhat incomplete, as will be seen from the following.

The ectoderm of thecaphore hydroids is apparently very uniform in point of development, and the nematocysts, which in the athecates furnished good material for study, seem in the thecaphores to vary but slightly, and should on the whole be referred to the same type as in *Athecata filifera*. This point is of some considerable interest as further confirmation of the old theory as to a closer relationship between the thecaphores and the mentioned group than between the thecaphores and *Athecata capitata*. Even among the *Grammaria*, where the nematocysts, in one species at any rate, are dimorphously developed, we can find no resemblance to the capsule form in *Athecata capitata*. The arrangement of the stinging cells also is very uniform in the thecaphores. As a general rule, we may say that the nematocysts in the thecaphores appear in marked transverse zones about the tentacles; the only exception I have found here is that of the gigantic *Bonneviella* polyps, where the zonate arrangement has become effaced.

A somewhat different organisation of the ectoderm is encountered in one or two families. The grown polyps of *Syntheciidae* and *Sertulariidae* have developed adhesive lamella, an exterior ectodermal lamella covering the inner side of the hydrotheca for a greater or lesser extent when the polyp has withdrawn into the same. It is this ectodermal lamella which Nutting (1904 p. 10) considers as one or more "protractors", evidently from more or less accidental breaks in the lamella, this being, in the living polyps, continuous. Nutting even goes so far as to base part of his system upon the number of "protractors", and is here followed by Broch (1905, 1909). These protractors, however, form, as pointed out by Kühn (1913 p. 66) an unbroken sheath or covering on the inner side of the hydrotheca, attached at its basal margin to the body of the polyp, and at the distal to the opercular apparatus. A similar arrangement is also found in *Aglaopheniidae*; here likewise we encounter lamellous extensions of the ectoderm, attaching the polyp to the inner ribs of the hydrotheca.

We see then, that the ectoderm itself gives us very little to go upon in a systematic classification. On the other hand, its derivatives, i. e. the periderm, will in the thecaphores be found of great importance in this respect. The thecaphores are, as we know, characterised by their stiff, almost

chitinous sheath, which is extended to form the hydrotheca. Incipient hydrotheca formation is found once or twice among the athecates, as for instance in *Perigonimus*, where a folding pseudo-hydrotheca surrounds the polyp below the tentacle whorl. Less attention has perhaps been paid to similar formations in a species such as *Eudendrium vaginatum* Allman, though even here we seem to find trace of an incipient hydrotheca. In the thecaphores, however, the hydrotheca has developed into a permanent component of the colony, and up to now, the systematic arrangement of the thecaphores as a whole has been based mainly upon the hydrotheca and its features. In some few families such as *Haleciidæ*, *Plumulariidæ* and *Siliculariidæ*, the hydrotheca is so small that the polyp cannot as a rule be withdrawn entirely into it; often, indeed, the hydrotheca seems merely to furnish a support for the basal part of the polyp. In view of the other structural conditions of the polyp, however, this must not be regarded as a purely primary feature, but should apparently in most cases be considered secondary, as is shown more particularly by the two first-named families. Despite the fact that the hydrotheca in *Lafoëidæ*, for instance, is far more highly developed, we must nevertheless, from the structure of the polyp, consider the last-mentioned family as representing a more primitive stage in the process of development.

A point of more importance is whether the ground plan of the hydrotheca is radial or bilateral. This again is generally connected with the presence or absence of stalk. The stalked, and thus free hydrotheca, will as a rule be constructed on a radial base type, as seen in *Lafoëidæ*, *Campanulinidæ*, and *Campanulariidæ*. The more or less marked curvings of the hydrotheca, not infrequently found particularly in *Lafoëidæ*, do not suffice to efface the radial base type, and even in *Lafoëidæ* and *Campanulinidæ*, where the hydrotheca is sessile or even partly fused with the stolons, the radial type is distinctly perceptible. In *Siliculariidæ*, on the other hand, the hydrotheca is assymmetrical or bilateral, the cause of which peculiarity it is by no means easy to comprehend, since the hydrotheca is quite freely set on its stalk, which is as a rule of considerable length. This family is, however, altogether but imperfectly known up to now. The sessile hydrotheca has a greater tendency to develop bilaterally. In the *Plumulariidæ*, this tendency is not yet quite pronounced; we find, however, that the diaphragm in most of the species takes up an oblique position relatively to the longitudinal axis of the hydrotheca. In *Aglaopheniidæ*, the development has proceeded considerably farther, the diaphragm here being either markedly oblique or else generally falling into two obliquely set portions, whereby the symmetry is arranged about a sagittal plane. This sagittal plane is often also found to be the plane of symmetry for the hydrotheca as a whole, the arrangement of the teeth at the opening being symmetrical according to the mentioned plane, while at the same time, a more or less marked lateral compression is observed in the hydrotheca. A similar bilateral development of the hydrotheca is encountered in *Syntheциidæ* and *Sertulariidæ*, where the diaphragm is as a rule also oblique, although rarely, if ever, falling so distinctly into two halves as in several of the *Aglaopheniidæ*. In *Sertulariidæ* also, the distal parts of the hydrotheca show a distinct bilateral construction according to the same sagittal plane as in the diaphragm.

A secondary formation in the hydrotheca, the closing apparatus, is likewise of considerable importance in systematic respects. In one genus of the *Lafoëidæ*, *Toichopoma*, we find a very primitive type of closing apparatus; the lid here is simply formed by the one side of the distal end of the

hydrotheca, which is somewhat thinner than the wall of the hydrotheca generally, and can be brought in over the aperture of the hydrotheca, so as to close it. Within the family of *Campanulinidae*, several types of lid have been developed, some consisting of the distal part of the hydrotheca (subfamily *Cuspidellinae*) others formed by the primary roof of the hydrotheca (subfamily *Calycellinae*). The closing apparatus in the first case consists of folding, membranous parts, roof-shaped or conical, covering the opening of the hydrotheca. In the latter case they form a conical roof, consisting partly of folding membrane, partly of triangular plates; in this group, the closing apparatus is always sharply marked off from the hydrotheca, whereas in the *Cuspidellinae*, it passes gradually over into the same. In *Sertulariidae* also, we find several forms of closing apparatus either consisting of some few separate triangular plates, and thus exhibiting the same type as certain *Campanulinidae*, or reduced to two — sometimes even a single plate — but they always appear to be formed from the original roof of the hydrotheca, in contrast to *Toichopoma* and *Cuspidellinae*.

These features have been the subject of general attention in systematic respects; less consideration, on the other hand, has been devoted to the different structural conditions in the polyps themselves, as arising from varying conditions in the endoderm.

In *Lafoëidae* and *Campanulinidae*, the endoderm is, as a whole, but little differentiated; here also, however, we find an oral part above the tentacle whorl, where the indifferent cells with small nuclei are decidedly in the majority, and the structure of the polyps here strikingly resembles that of the *Bougainvilliidae*. In *Haleciidae*, on the other hand, we find practically throughout, a marked distinction below the tentacle whorl between a fore-stomach and the actually digesting, basal part, the stomach itself. While the digestive cells in the former are decidedly in the minority, it is they alone which form the endoderm of the stomach. The same differentiation into two stomach sections is still more pronounced in *Plumulariidae*, and in the polyps of both families we must notice a ring-shaped, external constriction of the polyp, where the boundary between the two endodermal zones must be taken to lie. The same division of the endoderm of the polyp into two regions is likewise found in *Aglaopheniidae*, but it is not always so easily distinguishable here on mere external observation of the polyp, being in particular frequently obscured by the ectodermal extensions previously referred to, by which the hydranth is attached to the inner ribs of the hydrotheca.

Even more pronounced is the differentiation of the endoderm in most of the *Synthechiidae* and *Sertulariidae*. Here, the polyps are as a rule furnished with a single (ventral) blind sack placed abcaulinally to the colony. The endoderm of the stomach parts, otherwise formed by a high cylindric epithelium, forms in the blind sack only a low epithelium, which does not appear to contain digestive elements. This seems to suggest that Kühn's supposition (1913 p. 68) is correct, and that the abcauline blind sack in these families serves for storage of nutritive matter to be digested subsequently, when the polyp is again in a resting position. The abcauline blind sack must be said to be characteristic of the two families, even though in primitive forms such as for instance *Thyroscyphus* and *Dynamena*, only an indication of it may be found.

Finally, there is yet another type of polyp found in *Campanulariidae* and *Siliculariidae*. While all the remaining families of thecapores are characterised by a conical peristome, this is, in the two mentioned families, clubshaped, situate with a narrow base above the tentacle whorl on the broad

body of the polyp. In external habitus, the polyps of these families thus markedly resemble those of *Eudendriidae*, and the similarity in point of internal structure is equally remarkable. The endoderm of the peristome, or the proboscis, is quite predominantly composed of indifferent cells, while the gastral part has a fairly homogeneous endodermal covering of digestive cells. Owing to the deviation of the polyps in external habitus, I have in a former work, (1909 p. 133) marked off these two families as a separate sub-order, *Proboscoidae*. Considering the mentioned features of organisation, however, in the light of what has been stated above, it will hardly be correct to retain this sub-order; but it forms a special family series, ranking with the others, where the thecaphores as a whole must be said to fall, as will be further referred to in the following.

A much disputed group is formed by the genus *Bonneviella*, which I formerly (1909a) noted off as a separate family. Kühn (1913 p. 252) inclines to the view that the genus must be referred to *Lafoëidae*, whereas Nutting, in his latest work (1915 p. 94) retains the family of *Bonnevelliidae*. Such description as has been given of the anatomical conditions in this species is as a matter of fact not sufficient fully to elucidate the relationship of the group, and Nutting's explanation, in which he considers that my previous observations may be confirmed, still lacks the essential point required; to wit, the development of the so-called "veloid". A comparison with the remaining genera has led me rather to incline towards Kühn's theory, that the formation in question can hardly be regarded as altogether ectodermal, the inner layer being probably rather an extreme development of the indifferent cells of the endoderm. If this supposition prove correct — a point which can only be determined by study of the development of the polyps — the position of the genus will nevertheless still be doubtful; most of the facts would then seem to lead towards their inclusion as a high form of development of *Campanulariidae*; we may, however, also with good reason suppose the origin to be in *Lafoëidae*. Having no suitable material for further study of these questions available, I do not purpose here to enter upon further theoretical discussion as to the systematic position of the genus. I would merely point out once more, that the interpretation of the peristome as an ectodermal gullet is doubtful in the highest degree.

On summing up the above anatomical data, we find that the thecaphore hydroids fall into four main groups or series of families, which are of great interest from a phylogenetic point of view. The most primitive family series is that of *Hebellina*, with its conical proboscis and with homogeneous gastral endoderm. This group, which embraces the families *Lafoëidae*, and *Campanulinidae*, exhibits a marked affinity with the athecate family of *Bougainvilliidae*, and probably originated from the same.

From *Hebellina* again, two new family series are derived, viz: on the one hand that of *Haleciina*, with the families *Halceiidae*, *Plumulariidae*, and *Aglaopheniidae*, and on the other, the series *Sertulariina*, with the families of *Syntheceiidae* and *Sertulariidae*. *Haleciina* is characterised by its bipartite gastral portion, which is divided into a fore-stomach (probably non-digesting) and a digestive basal part. This division is, especially in certain primitive *Halcium* species, still but slightly pronounced, thus giving the transition from *Hebellina*. In *Sertulariidae*, on the other hand, the basal, one-sided blind sack is developed as a storage chamber; the transition from *Hebellina* is here represented by forms such as *Thyroscyphus*, where the partition of the gastral parts into the divisions named is still barely indicated.

An exceptional position is that of the *Proboscoidae* series, with club-shaped proboscis. The

group may be supposed to originate from *Hebellina*; there is, however, much which would seem to suggest closer relationship with *Eudendriidae*. I have in a previous work (1909 p. 132) drawn attention to several features pointing in this direction; Kühn, (1913 p. 246) endeavours to disprove the close resemblance, while on the other hand Nutting, (1915 p. 20) notes further similarities, and, like Stechow, (1913 p. 22) comes to the conclusion that a close relationship between *Proboscoida* and *Eudendriidae* is not to be denied. I would here merely mention one point, which Kühn regards as of great importance, but which Nutting has not subjected to closer consideration. Kühn finds that there is a difference of principle in the gonosomes. In this connection, several of the gonangia of the *Campanulariidae* will be found of considerable interest. In the athecates, we repeatedly find that single gonophores, as in *Bougainvillea*, *Hydractinia*, and *Eudendrium*, collect on the stalks of some few hydranths; in several species moreover, we find a reduction of the terminal polyp, so that the whole of the gonophoriferous complex is here transformed into a blastostyle. As a matter of fact, we have in such cases to deal with gonangia aggregates, differing only in gonotheca formation from the gonosome in species such as for instance *Laomedea flexuosa*. The development of the gonangia here shows us a reduced terminal polyp, which has now formed an "Endplatte", on the stalks of which gonophores appear. If at the same time we imagine that the gonophores do not penetrate the perisarc, but that the latter expands instead into a protecting sheath, we have then the gonotheca in its typical form for *Campanulariidae*. It may also be imagined as arising by formation of gonophores on the basal parts of the hydranth, within the hydrotheca, when, on the one hand, the hydranth will thereby be reduced to an "Endplatte", while on the other hand, hypertrophy of the hydrotheca will set in. Either of these alternatives may be considered as the possible starting point. I do not insist that this explanation of the origin of the gonosome in the group is the correct one; there is, however, nothing to disprove it in the results of investigations made up to date, and it will, if confirmed, altogether disprove the existence of a difference of principle in the gonosomes, as maintained by Kühn. This proof is thus likewise inadmissible as finally disposing of the supposition of a closer relationship between *Proboscoida* and *Eudendriidae*.

If we now endeavour, as in the case of the athecates, to summarise the elucidated features and previous views in a key for determination, we must at the outset point out that in this instance such a method cannot so easily be employed without reserve, as the transitions in the thecaphores are more gradual than in the athecates. An endeavour may nevertheless be made to draw up a scheme of the nature indicated.

I. Polyps with conical, pointed oral part.

A. The gastral endoderm uniformly developed; polyps and hydrothecæ constructed according to a radially symmetric ground plan. (Family series **Hebellina**).

I. Hydrothecæ without opercula or with a primitive closing apparatus formed from the thinner distal part of one side of the hydrotheca. Family *Lafoëidae*.

II. Hydrothecæ with roof-shaped or conical opercula of composite structure. Family *Campanulinidae*.

B. Gastral endoderm differentiated in heterogeneous parts.

I. Polyps with fore-stomach and digestive basal stomach parts. (Family series **Haleciina**).

- a. Hydrothecæ small, radially symmetrical, cannot accommodate the contracted hydranth. Family *Haleciidæ*.
- b. Bilaterally symmetrical hydrothecæ, with obliquely set diaphragm.
 - x. Diaphragm simple. Hydrothecæ small, approximately radial structure, generally without teeth; rudimentary or stalked and mobile, two-chambered sarcotheca. Family *Plumulariidæ*.
 - xx. Diaphragm generally composed of two obliquely set portions; hydrothecæ markedly bilateral, large, most frequently toothed. Sarcothecæ all or some one-chambered, sessile and immobile. Family *Aglaopheniidæ*.
- II. Polyps with a basally situate, ventral blind sack with low endoderm cells. Hydrothecæ generally bilateral. (Family series **Sertulariina**).
 - a. Hydrothecæ without opercula. Family *Syntheциidæ*.
 - b. Hydrothecæ with opercular apparatus. Family *Sertulariidæ*.
- 2. Polyps with club-shaped or trumpet-shaped oral parts. (Family series **Proboscoida**).
 - A. Hydrothecæ large, radially symmetrical. Family *Campanulariidæ*.
 - B. Hydrothecæ small, thick-walled, and bilaterally symmetrical. Family *Siliculariidæ*.

II. Thecaphore Hydroids of the Northern Atlantic.

Family series *Hebellina* nov.

Family *Lafoëidæ*.

Hydrothecæ deep bell- to tube-shaped, radially symmetrical after their ground plan, stalked or sessile, at times partly fused with the mother tube; diaphragma rarely present. The hydrothecæ without opercula; exceptionally, the distal end of the one wall in the hydrotheca may fold in over the aperture. The colonies are stolonial or sympodial. The polyps are radially symmetrical, with conically pointed oral part; the endoderm is divided into an oral and a gastral part; the gastral endoderm is homogeneous.

The structure of the polyps gives this family a primitive rank among the thecaphores, and among its lowest genera *Hebella* must be counted as taking a typical position; this genus is, however, especially distributed in the warmer seas. The genus has also been recorded from northern waters, although evidently erroneously; its only northern representative should be *Hebella pocillum* (Hincks) but as it lacks the diaphragm, it cannot be allowed to remain in this genus, and its identity will be dealt with later on.

In course of time, a whole series has been set up with genera of *Lafoëidæ*, and on going through the list compiled by Stechow (1913 p. 44) we find that considerable weight is attached to the accumulation of the gonangia in aggregates (scapus, coppinia) or their appearing singly. I have recently (1917) in studying the coppinia of *Grammaria abietina*, set forth what we know up to the

present concerning this distinguishing feature; our knowledge is, in reality, so insufficient that the greatest care should be exercised in answering for species even where this character has been noted, after superficial study, as the only point of difference in comparison with the nearest related species. It is clear, that in certain species, the gonothecæ of the one sex (the female) appear aggregated as scapus or coppinia, while those of the other sex (the male) occur singly. Even though we may not at present possess definite proof, it is nevertheless highly probable that also certain *Lafoëidæ* may have unisexual colonies; in such case, however, the occurrence of the gonothecæ singly or in aggregates will even fail us as a specific character. Obviously then, in the present imperfect state of our knowledge as to the gonangia of the different species, the feature in question must be discarded altogether as a generic character. Until we know more about the matter, it will certainly be most correct to disregard the question of gonangia entirely when drawing the limitations of the various genera.

Gen. *Lafoëa* (Lamouroux).

The colony consisting of upright rhizocaulome formations, or creeping, with tubular or narrow bell-shaped hydrothecæ. The hydrothecæ are without diaphragma or opercular apparatus, stalked or sessile, in the latter case separated from the stolon by a more or less marked constriction; where the hydrotheca lies adjoining the stolons, it is possible to distinguish between the wall of the hydrotheca and that of the stolon.

A whole series of species belonging to this genus have been described from the northern seas, and many of them are based on the distinction as to whether the colonies are creeping or upright, a character which, as we find on closer investigation, can only be applied with the greatest caution. It has long been recognised that *Lafoëa dumosa* may either occur as a creeping form, or may form upright rhizocaulome colonies; this fact in itself should be sufficient to point the necessity of careful consideration, and a closer study of the northern species reveals the fact that one and the same species may at times occur creeping, at others form upright colonies, when some few stolons emancipate themselves from the underlayer and thus form a suitable substratum over which other stolons may creep.

Another feature in the *Lafoëa* species which renders their limitation exceptionally difficult is their extraordinary power of variation. Such variation is evidently due in part to the influence of physical conditions in their environment, which have led to the formation of gigantic arctic forms, or heavily built, robust cold-water forms. Critical study of the very extensive material available has thus led to considerable reduction in the number of species.

Lafoëa dumosa (Fleming) L. Agassiz.

1828 *Campanularia dumosa*, Fleming, A History of British Animals, p. 548.

1860 *Lafoea dumosa*, L. Agassiz, Contributions to the Natural History of the United States, p. 351.

Colonies creeping or upright, irregularly branched and stiffly built rhizocaulome formations. Hydrothecæ developed slightly asymmetrically, tubular, with slightly outward curving margin; they

are separated by a constriction from the stolons, or may, more rarely, exhibit an indication of stalk, forming half a spiral whorl.

The gonangia are collected in coppiniæ with tubes much twisted. The coppiniæ are hermaphroditic, with the male gonothecæ wedged in among the female.

Material:

- "Ingolf" St. 6, $63^{\circ}43' N.$, $14^{\circ}34' W.$; depth 90 fathoms, $7,0^{\circ}$
 — - 86, $65^{\circ}03,6' N.$ $23^{\circ}47,6' W.$; — 76 — (West-Iceland)
 — - 87, $65^{\circ}02,3' N.$ $23^{\circ}56,2' W.$; — 110 — (West-Iceland)
 "Thor" $63^{\circ}30' N.$ $20^{\circ}14' W.$; — 80 metres
 Greenland: Sukkertoppen (on *Bollenia*) (no further data)
 Iceland: Vestmannö depth 28 fathoms
 — Skjálfandi Bay depth 28 fathoms
 The Faroe Islands: $62^{\circ}29' N.$, $7^{\circ}37' W.$; depth 110 metres, $8,71^{\circ}$
 — — $62^{\circ}16' N.$, $6^{\circ}06' W.$; — 110 —
 — — 7 miles N. by E. of Myggenæs point; depth 57 fathoms
 — — 6 — N. by W. of Store Kalsö; — 60 —
 — — Deep hole at north point of Nolsö; — 100 —
 — — Borönæs N. $75 W.$ — 30° —

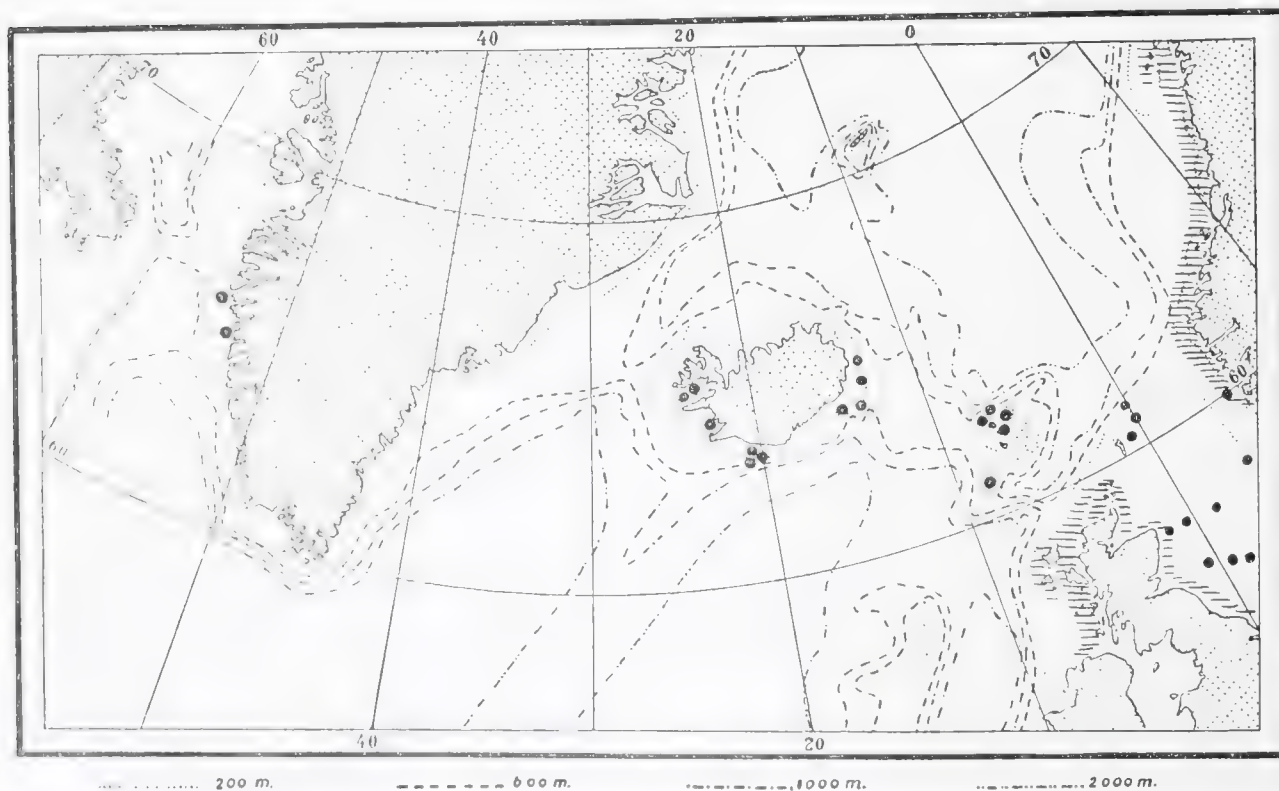


Fig. 1. The Distribution of *Lafoëa dumosa* in the Northern Atlantic.
 In the hatched regions the literature notes a common occurrence.

Some writers unite this species with the two following; this is, however, as I have previously shown (1908 p. 33) not correct. Both in its creeping form and in the upright colonies it is very typically distinct from the remaining northern *Lafoëa* species, partly by its very slightly asymmetrical hydrothecæ, which have practically no real stalk at all, partly by the fact that the hydrothecæ, which are set very far apart, form almost a right angle with their corresponding stolon.

The species is widely distributed in the northern seas (Fig. I). It is a distinctly boreal species, which can, however, penetrate far into southern waters, and has been recorded, for instance, from the Mediterranean (Babić 1910 p. 213). On the other hand, purely arctic conditions seem quickly to set a limit to its progress.

***Lafoëa gracillima* (Alder) Hincks.**

1856 *Campanularia gracillima*, Alder, A notice of some new genera and species, p. 361, pl. 14 figs. 5—6.

1874 *Lafoëa gracillima*, Hincks, Notes on Norwegian Hydroids from deep-water, p. 132.

1868 *Lafoëa pygmaea* pars, Hincks, A History of the British Hydroid Zoophytes, p. 205, pl. 40 fig. 3.

1887 *Lafoëa fruticosa* pars, Bergh, Goplepolyper (Hydroider) fra Karahavet, p. 334.

The colony is creeping or upright, with irregularly branched rhizocaulome formation. The hydrothecæ are narrow, tubular, curved, with the convex side turned upwards; the opening margin is on the concave (lower) side never curved outwards, but may be slightly so on the convex side of the hydrotheca. The hydrotheca passes gradually over into the stalk, which is of varying length, and with a spiral coil closer in some, more open in others. In upright colonies, the stalk axis forms as a rule a very acute angle with that of the mother tube, the basal part of the hydrotheca is often nearly parallel with the latter.

The gonothecæ are compressed in hermaphroditic coppiniæ, the long tubes of which are as a rule highly curved. The male gonothecæ occur wedged in between the female.

Forma *typica*: finely built colonies, with hydrothecæ set wide apart; the hydrothecæ entirely tube-shaped, with loosely spiral stalk, as a rule with two turns.

Forma *elegantula*: colonies of coarser build, with closely set hydrothecæ; the hydrothecæ often with the upper part of the opening margin curved slightly outwards; stalk with a varying number of mostly close spiral windings.

Material:

Forma *typica*:

"Ingolf" St. 1,	62°30' N.,	8°21' W.,	depth 132 fathoms	7,2°
— - 55,	63°33' N.,	15°02' W.,	— 316 —	5,9°
— - 85,	63°21' N.,	25°21' W.,	— 170 —	—
— - 87,	65°02,3' N.,	23°56,2' W.,	— 110 —	—
— - 95,	65°14' N.,	30°39' W.,	— 752 —	2,1
— - 127,	66°33' N.,	20°05' W.,	— 44 —	5,6°
Iceland: Skagestrand			— 44 —	

9 miles N.74E. of Hornet, east coast of Iceland, depth 38 fathoms

62°17' N., 4°57' W., depth 144 fathoms.

Forma elegantula:

"Ingolf" St. 3,	63°35' N.,	10°24' W.,	depth 272 fathoms,	0.5°
— - 29,	65°34' N.,	54°31' W.,	— 68 —	0.2°
— - 31,	66°35' N.,	55°54' W.,	— 88 —	1.6°
— - 33,	67°57' N.,	55°30' W.,	— 35 —	0.8°
— - 34,	65°17' N.,	54°17' W.,	— 55 —	—

Greenland: Davis Strait (precise locality not stated) depth 100 fathoms.

Akudlek	(no further data)
Egedesminde	(- — —)
Mouth of Ameralikfjord	(- — —)
Sukkertoppen, on <i>Boltenia</i>	(- — —)
Jakobshavn	(- — —)
Hurry Inlet, depth 0—7 fathoms (East Greenland Expedition)	
— — 57	(— — —)
Harry Land — 20	(— — —)

Iceland: "Thor" 52 miles E. of Langanes

Skjalfandi Bay, depth 28 fathoms

9 miles N. 74 E. of Hornet, east coast of Iceland, depth 38 fathoms

64°17.5' N., 14°44' W., depth 40 fathoms, 5.12°

The Faroe Islands: 61°40' N., 7°40' W., — 135 —

6 miles N. by W. of Store Kalsö, depth 60 fathoms

Kara Sea "Dijmphna" (labelled *Lafoëa fruticosa*).

The distinguishing features between *Lafoëa gracillima* and *Lafoëa fruticosa* may often appear very insignificant, and in arctic waters especially one may often be in doubt as to whether a specimen is a robustly built colony of *L. gracillima* forma *elegantula* or a finely built *L. fruticosa* forma *gemma*. The feature emphasised by Bonnevie (1899 p. 61) viz: the number of spiral turns on the stalk, is in particular extremely variable in somewhat larger colonies, and it is likewise found that the angle between stalk and mother stolon, especially among creeping colonies, is little to be relied on. Another feature, however, to which I have long since drawn attention (1907 p. 7) seems to be more constant, and will also according to the present material serve to determine the identity of species. The feature in question consists in the fact that the abcauline concave side of the hydrotheca in *Lafoëa gracillima* lacks the basal convexity found in *Lafoëa fruticosa*, and that the margin of the hydrotheca on this side is never curved outwards in *Lafoëa gracillima*, in contrast to *Lafoëa fruticosa*, where the lower (concave) side of the hydrotheca is thus always more or less S-shaped in profile.

Among the synonyms for *Lafoëa gracillima* we have also here included *Lafoëa pygmaea* pars. Jäderholm (1909 p. 80) includes this species as a synonym under *Calycella syringa*, and he is undoubtedly right in so doing. According to Hincks (1868 p. 205) the original drawings by Alder exhibit indications of opercular formation in the hydrotheca here and there, a point which beyond question suggests this species. On the other hand, Hincks's description is entirely in agreement with the

creeping colonies of *Lafoëa gracillima*, and a number of colonies which have later been identified as *Lafoëa pygmaea* should doubtless be referred to *Lafoëa gracillima*. Bonnevie, (1899 p. 62) notes in her table as to the hydrothecæ that they have "slightly outward-curving margin"; this does not agree with Hincks's expression "hydrothecæ . . . cylindrical, elongate and narrow" or with his drawing of the species. In my first report on the hydroids from "Michael Sars" (1903 the table) I recorded *Lafoëa pygmaea* from several localities, giving also a drawing of the coppinia of the species; subsequent revision of the material has shown me that the specimen indicated is, like most of the others, a typical, creeping *Lafoëa gracillima*, while some few colonies are creeping *Lafoëa dumosa*. *Lafoëa pygmaea* must

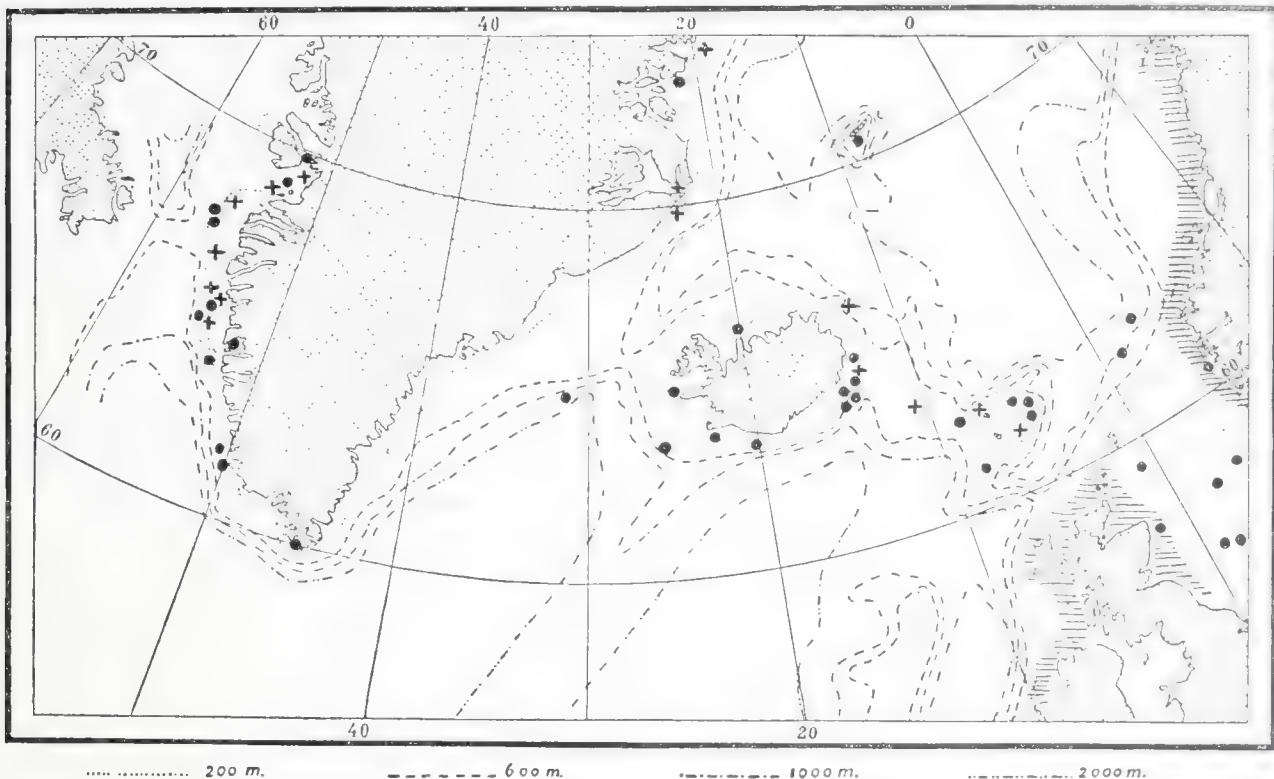


Fig. II. Localities of *Lafoëa gracillima* forma *typica* ● and forma *elegantula* + in the northern Atlantic.

In the hatched regions the literature denotes a common occurrence of the species.

(The dates from British seas are incomplete on account of a general confusion with *Lafoëa fruticosa*).

thus mainly be regarded as synonymous with *Lafoëa gracillima* and *Calycella syringa*, and can accordingly no longer be counted as an independent species.

Lafoëa gracillima appears in two forms, affording parallels to those of the following species. The finely built forma *typica* is quite cosmopolitan in its occurrence, and has been met with in all seas from pole to pole. In arctic — and as far as can be seen also antarctic — waters, there has also developed, in addition to forma *typica*, a more robust and closely built forma *elegantula*, the stalk of which generally commences with a single loose winding, continuing then in a varying number of close turns. Forma *elegantula* is, as mentioned, arctic, but may (text fig. II) also at times penetrate into boreal waters.

Lafoëa fruticosa M. Sars.

- 1851 *Campanularia fruticosa*, M. Sars, Beretning om en i Sommeren 1849 foretagen zoologisk Reise, p. 131, 138.
 1863 *Lafoëa fruticosa*, M. Sars, Bemærkninger over fire norske Hydroider, p. 30.
 1868 — *pocillum*, Hincks, A History of the British Hydroid Zoophytes, p. 204, pl. 40, fig. 2.
 1874 — *grandis*, Hincks, On deep-water Hydroida from Iceland, p. 147, pl. 6, figs. 1–2.
 1899 — *symmetrica*, Bonnevie, Norske Nordhavs-Expedition, p. 64, pl. V, figs. 2 c and 4.

The colonies are creeping, or form upright, irregular rhizocaulomes. The hydrothecæ are cylindrical or narrowly bell-shaped, more or less asymmetrically developed or slightly curved, the one side as a rule curving somewhat more markedly outwards than the other. The hydrothecæ have as a rule a slightly expanded basal part and a more or less outward curving opening margin, they are sharply marked off from the stalk, which is of varying length, spirally turned, or less frequently divided into rings. The stalk itself forms, in the upright colonies, an open angle of 45°–80° with the mother tube.

The gonothecæ are gathered in hermaphroditic coppinæ, the tubes of which are as a rule highly curved. The male gonothecæ are wedged in among the female.

Forma *genuina*: finely built colonies, always with asymmetrical, narrow hydrothecæ, the stalk forming an acute angle with the mother tube.

Forma *grandis*: coarsely built colonies with wide cylindrical to narrowly bell-shaped hydrothecæ; hydrothecæ often almost or entirely symmetrical, the stalk generally forming a more obtuse angle with the mother tube.

Material:

Forma *genuina*:

"Ingolf" St. 34	65°17' N.,	54°17' W.,	depth	55 fathoms
— - 86	65°03,6' N.,	23°47,6' W.,	—	76 —
- - 87	65°02,3' N.,	23°56,2' W.,	—	110 —
"Thor"	65°52' N.,	23°58' W.,	—	62 metres
—	61°07' N.,	9°30' W.,	—	835 —

Greenland: Egedesminde (no details noted)

Proven (- - -)

Cape Tobin, depth 57 fathoms (East Greenland Expedition)

Mouth of Hurry Inlet, — 50 — (— — —)

Iceland: Skjalfandi Bay, depth 28 fathoms

9 miles N. 74 E. of Hornet, east coast of Iceland, — 38 —

The Faroe Islands: 7 miles N. by E. of Myggenæs, — 57 —

Forma *grandis*:

"Ingolf" St. 2	63°04' N.,	9°22' W.,	depth	262 fathoms	5,3°
— - 4	64°07' N.,	11°12' W.,	—	237 —	2,5°
- 34	65°17' N.,	54°17' W.,	—	55 —	—
— - 95	65°14' N.,	30°39' W.,	—	752 —	2,1°

Greenland: Egedesminde, depth 30—40 fathoms

Sukkertoppen, on *Boltenia* (no details noted)

Ingmikertok, Angmagsalikfjord (depth not given) (East-Greenland Expedition)

Iceland: 33 miles SE. $\frac{1}{2}$ E. of Stokkesnæs near Hornsvig, depth 84 fathoms (labelled *Lafoëa fruticosa*).

We have here a species of highly variable character, especially in the northern waters, where the biophysical factors evidently exercise an important and determinative influence upon the variation of the species. There is consequently also much confusion as to the synonymy of the species. *Lafoëa fruticosa* was established by M. Sars (1849) and in his description we find the following with regard to the hydrothecæ: "superne latoribus, inferne coarctatis". This certainly gives the impression of a hydrotheca having its lower portion, partly on account of the curvature of the wall, broader than the upper, which again expands nearer the opening. The same is also seen in the drawing subsequently given by G. O. Sars (1873 Tab. IV, figs. 17—18) of the species, undoubtedly based upon M. Sars's type specimens. This does not agree with the statements of Bonnevie (1899 p. 65) and we can hardly help feeling that among Bonnevie's *Lafoëa fruticosa* there must also be some colonies of *Lafoëa gracillima* forma *elegantula*; a supposition which is, moreover, confirmed by the study of her material in Christiania. On the other hand, Bonnevie has (l. c.) established an entirely new species, *Lafoëa symmetrica*, which as a matter of fact is based upon variants of *Lafoëa fruticosa*. The principal difference between *Lafoëa fruticosa* and *Lafoëa symmetrica* is, according to Bonnevie, the fact that the latter species has symmetrical hydrothecæ, whereas these are of asymmetrical structure in the former. It will be seen, however, from the drawings of hydrothecæ given (1899 Tab. V, fig. 2 c') that asymmetrical hydrothecæ can also occur in *Lafoëa symmetrica*. On the other hand, further examination of the hydrothecæ in *Lafoëa fruticosa* (cf. Broch 1908 fig. 4, 1909 textfig. 19) shows that the asymmetry is often but very slightly pronounced, and even disappears altogether in a greater or lesser percentage of the hydrothecæ in a fairly large colony. We find, in other words, that in this respect, every imaginable transition form may be met with from *Lafoëa fruticosa* to *Lafoëa symmetrica*; the character in question is therefore not suitable for purposes of specific distinction. There remains then, the size, which is said to differ as between *Lafoëa fruticosa*, *L. symmetrica*, and *L. grandis*. It is soon found, however, that this character likewise is here unserviceable. On the one hand, the three species form, according to Bonnevie, a finite series of sizes, *Lafoëa symmetrica* being from the drawings and description, larger than *Lafoëa fruticosa*, but smaller than *Lafoëa grandis*. On the other hand, a large material of the three forms reveals the fact there is no discernible interval throughout the series; all intermediate stages are found, from finely built colonies of *Lafoëa fruticosa* to such extreme cold-water variants as those upon which Hincks's *Lafoëa grandis* is based. We are thus compelled to include the forms under one species, the correct name of which should be *Lafoëa fruticosa*.

The amalgamation of these three species into one, however, involves the further abolition of *Lafoëa pocillum* Hincks (1868 p. 204, pl. XL, fig. 2). The shape of the hydrothecæ is very correctly described by Hincks as follows: "tumid below, with the sides curved inwards above, and expanding again slightly towards the top". This coincides entirely with M. Sars's "superne latoribus, inferne coarctatis". The length of the stalk in *Lafoëa* species and its spiral winding or division into separate

rings varies even within a single large colony to such a degree that the features in question cannot be taken as distinctive specific characters, unless combined with others more sound. There remains then the creeping form of colony. But *Lafoëa fruticosa* here differs in no wise from the remaining species of the genus; its colonies may be pure upright rhizocaulome formations, but this is very rarely the case. Generally, the somewhat larger colonies consist partly of upright, partly of creeping portions, and it is very common to meet with such composite colonies, when they are brought up with the underlayer attached. Exclusively creeping colonies thus merely form the other extreme in the

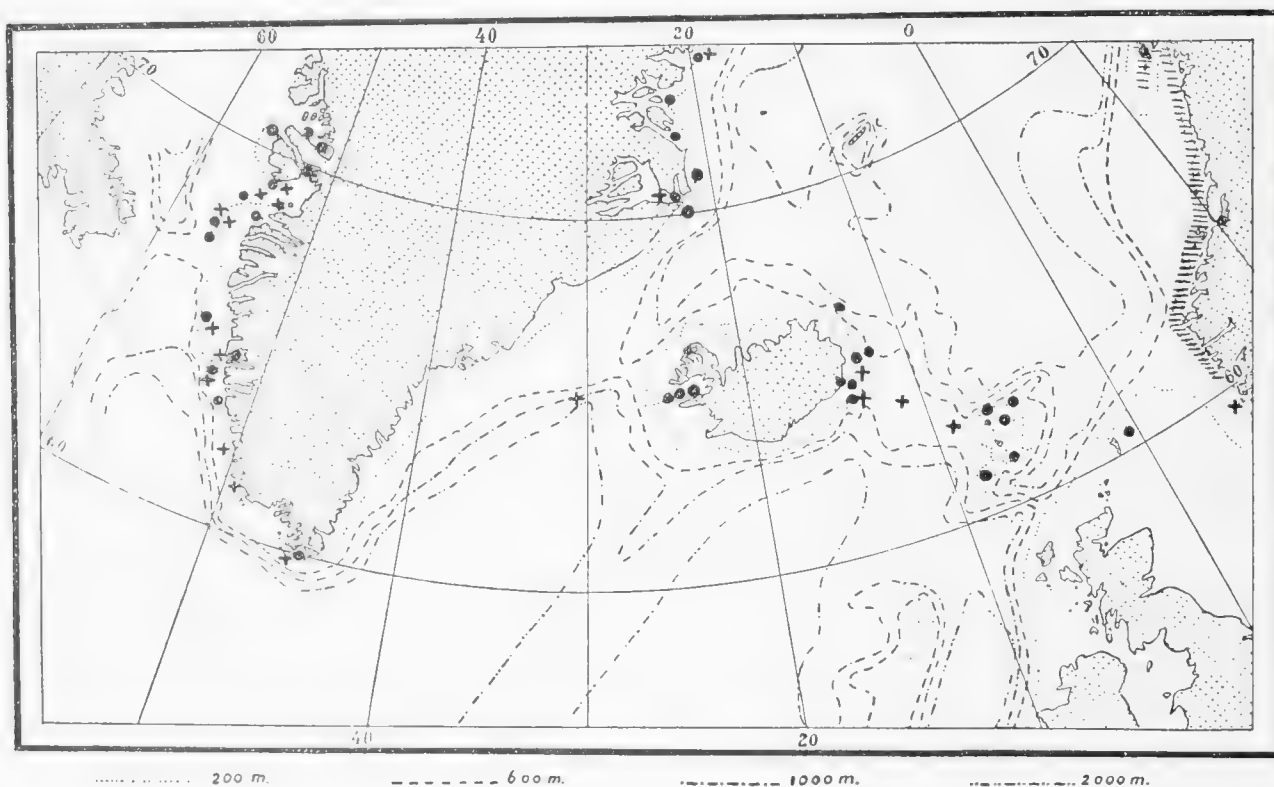


Fig. III. The distribution of *Lafoëa fruticosa* forma *genuina* ● and forma *grandis* + in the northern Atlantic.

The hatched region denotes a common occurrence of *Lafoëa fruticosa* according to literature.

(In British waters the dates are to be revised owing to confusion of the species with *Lafoëa gracillima*).

same series of variants. Consequently therefore, *Lafoëa pocillum* must be discarded, as being synonymous with *Lafoëa fruticosa*.

Jäderholm (1909 p. 71) follows, stating no particular reason, the example of Nutting (1901 p. 175) and ascribes *Lafoëa pocillum* to the genus *Hebella*. Nutting, in his diagnosis of this genus, states as follows: "Hydrothecæ . . . having their cavities separated from those of the stem by a partial septum". Such septum or diaphragm is altogether lacking in the European specimens of *Lafoëa pocillum*.

It must not be forgotten, however, that the former species partly owe their existence to external determining factors. Disregarding the creeping form of colony as opposed to the upright, the differences presented by the colonies in a less extensive material are considerable enough to warrant at any rate temporary distinction of species, and it would in these cases be incorrect not to notice the

same. Such "species" will on further investigation often be found to represent regular groups of variants. And this is precisely the case here. In *Lafoëa fruticosa*, the transition forms are not infrequent in boreal waters, and it may often appear doubtful where the limits should be drawn. It is perfectly admissible, in the case of *Lafoëa fruticosa*, to distinguish between a forma *genuina* as opposed to forma *grandis*, the first-named comprising that group of variants hitherto indicated as *Lafoëa fruticosa*, and the latter embracing the species *Lafoëa grandis* and *Lafoëa symmetrica*. The two forms also make typical geographical groups.

Forma *genuina*, which must be regarded as the mother form, is of very wide distribution; it is encountered together with the following form (text fig. III) in the arctic region, and alone in boreal and southern waters, both in the Atlantic and the Pacific, where it has been met with so far down as Hawaii. Intermediate forms are, as mentioned, frequently found in boreal and arctic waters, more particularly in the transition zones between the two.

Forma *grandis* is of strictly arctic occurrence, and must here be regarded as a typical character form. Billard's record (1907 p. 176) of a find at Cape Spartel must, from the measurements and figures given, be due to incorrect diagnosis.

Gen. *Toichopoma* Levinsen.

The colonies are creeping, or form upright, irregularly branched rhizocaulomes, with stalked, cylindrical hydrothecæ. The hydrothecæ lack the diaphragm, but have a primitive closing apparatus; the distal integral part of one side of the hydrotheca wall can be closed down over the aperture.

Toichopoma obliquum (Hincks) Levinsen.

1874 *Calycella obliqua*, Hincks, On deep-water Hydroida from Iceland, p. 149, pl. 6, figs. 4-5.

1893 *Toichopoma obliquum*, Levinsen, Meduser, Ctenophorer og Hydroider, p. 178.

1911 — — Kramp, Report on the Hydroids, p. 374, pl. XX, fig. 4, pl. XXIII, figs. 5-8, pl. XXIV, fig. 1.

The colonies are creeping, or form upright irregularly branched rhizocaulomes. The hydrothecæ have a short stalk with a varying number of spiral windings; they are cylindrical, curved, with an adcauline convexity, as a rule somewhat expanded near the base, and slightly broader again near the aperture, which in open hydrothecæ is somewhat asymmetrical; the hydrotheca passes gradually over into the stalk. The abcauline distal part of the aperture is thin, and can be closed in towards the opposite wall over the contracted polyp.

The gonothecæ are closely packed in a (hermaphroditic?) coppinia on stem or branches; the single gonothecæ are pentagonal or hexagonal, with a short, narrow cylindrical neck. Between the gonothecæ are inserted long, highly curved tubes, forming a close network over the coppinia.

Material:

Greenland: Jakobshavn (no details noted)

Egedesminde (- — —)

Toichopoma obliquum is a high arctic species, recorded both from West and East Greenland, as well as from Spitzbergen and the Murman Sea.

Gen. *Grammaria* (Stimpson).

Colonies creeping or forming upright, irregularly branched rhizocaulomes with sessile, cylindrical hydrothecæ, which are to a varying extent fused with the tubes, so that in this part it is impossible to distinguish between the wall of the hydrotheca and tube. The hydrothecæ can at times exhibit a basal constriction forming a boundary between them and the mother tube, but such constriction may also often be wanting. Diaphragm and operculum lacking.

In earlier works, the creeping species have been incorrectly noted as a separate genus, *Filellum*. The type of this genus was *Filellum serpens* (Hassall). I have previously (1912 p. 10) pointed out that this species should be classed under *Grammaria*, and am supported here by Kramp (1914 p. 1030). Further proof is afforded by Stechow, who describes (1913 p. 118) a species *Grammaria scandens*, with both creeping and upright colonies; it would seem doubtful whether this species should properly be maintained beside *Grammaria abietina*, which may often be found in Thronhjelm Fjord in the same manner. Stechow (l. c. p. 121) considers, however, that the genera should be maintained, "da ihre Beibehaltung eine grosse Bequemlichkeit für die Bestimmung ist".

Grammaria serpens (Hassall) Broch.

1848 *Campanularia serpens*, Hassall, Catalogue of Irish Zoophytes, p. 2223.

1868 *Filellum serpens*, Hincks, A History of the British Hydroid Zoophytes, p. 150.

1912 *Grammaria serpens*, Broch, Hydroida from the "Michael Sars", p. 10.

Colonies creeping. Hydrothecæ cylindrical, bent to an angle, the basal part fused with the stolon. The hydrotheca is tubular, quite cylindrical, or with slightly outward curving opening margin; the transition to the stolon is as a rule marked by a slight constriction.

The gonothecæ are collected in close coppiniæ, with highly curved tubes. They are hermaphroditic, with the male gonothecæ wedged in between the female.

Material:

"Ingolf" St. 87 65°02,3' N., 22°56,2' W., depth 110 fathoms

"Thor" 64°16' N., 22°17' W., — 50 metres

— 64°02' N., 22°33' W., — 34 —

— 63°30' N., 20°14' W., — 80 —

Greenland: Egedesminde (without further details)

Store Hellefiskebanke (— — —)

Davis Strait (— — —)

Iceland: Vadlevik, depth 80 fathoms

33 miles SE. of Stokkesnæs near Hornvig — 84 —

9½ — S. by W. ½ W. of Ingolfshofdi, depth not given

The Faroe Islands: 8—10 miles N. of the Faroe Islands (without further details)

7 miles N. by E. of Myggenæs point, depth 57 fathoms

6 miles N. by W. of Store Kalsö	depth 60 fathoms
Deep hole at north point of Nolsö	— 100 —
Borönæs 1 $\frac{3}{4}$ miles in N. 75 W.,	— 30 —
5 miles SSE. of Bispen	— 50 —
13 — W. by S. of Munken	— 150 —
Stokken 2 miles in S. 22 E.	— 55 —

This remarkable species was formerly considered as the type of the genus *Fillellum*. Bonnevie (1899) notes it under *Lafoëa*, but it should, as I have indicated above, be classed under the genus

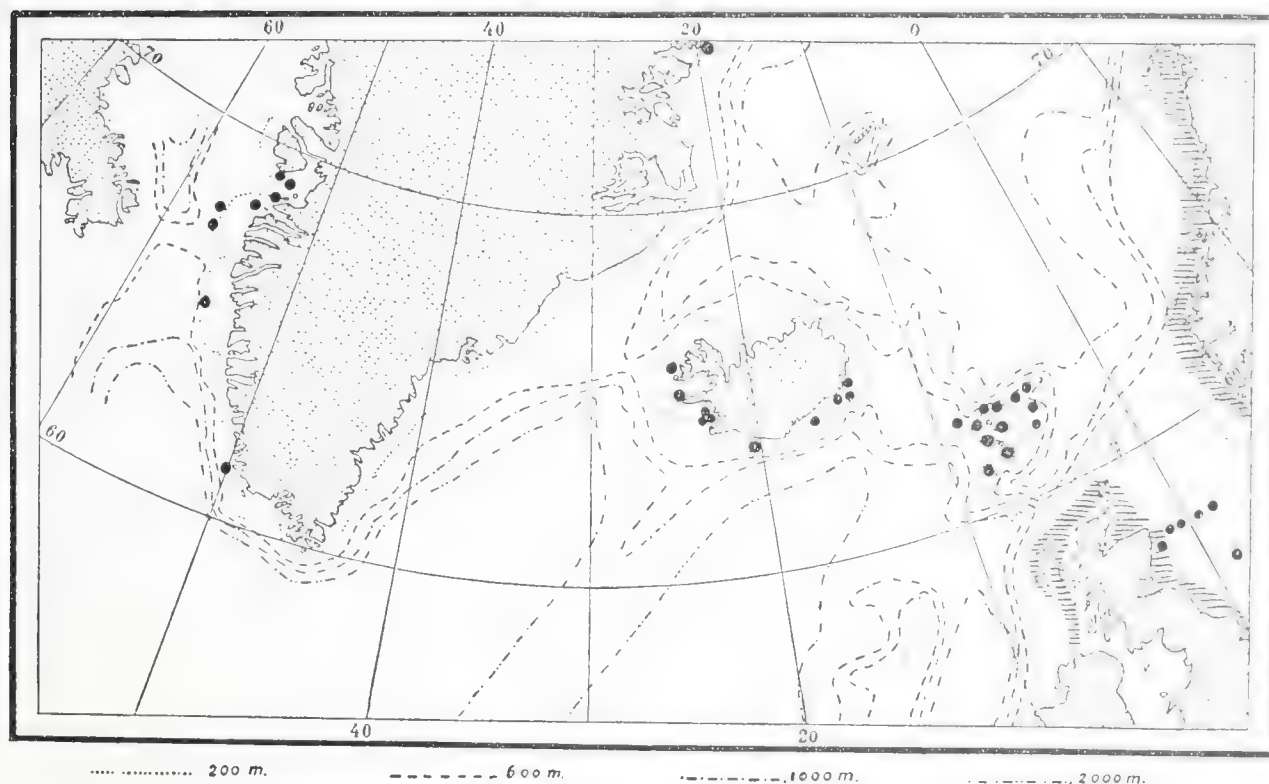


Fig. IV. The occurrence of *Grammaria serpens* in the Northern Atlantic.

In the hatched regions the literature notes a common occurrence.

Grammaria. From the records, the species is of highly cosmopolitan distribution; it is less numerous, however, in the arctic seas, and is likewise not altogether of common occurrence in warmer waters. It is most frequently met with in the mid-littoral parts of the boreal region (fig. IV) and is here but rarely found at greater depths.

***Grammaria conferta* (Allman) Broch.**

1877 *Cryptolaria conferta*. Allman, Report on the Hydroida of the Gulf Stream, p. 17, pl. 12, figs. 6—10.

1912 *Grammaria conferta*, Broch, Hydroida from the "Michael Sars", p. 10.

Upright, irregularly branched rhizocaulomes, the outer ramifications monosiphonic, the basal

parts polysiphonic. The hydrothecæ are arranged on the branches and stem in two opposite rows, alternating, with the mouth turned now to one side, now to the other. The hydrothecæ are large, tubular, passing by a slightly marked constriction over into the stolon; the diaphragm is lacking. In its proximal part, the hydrotheca is fused with the stolon; owing to a sharp bend in the hydrotheca, the distal part is almost perpendicular to the proximal. Opening margin slightly everted.

The gonothecæ are set close together in a (hermaphroditic?) scapus (without inserted tubes) on the branches or stem. The gonothecæ are bottle-shaped, with a short neck.

Material:

"Ingolf" St. 11	64°34' N.,	31°12' W.,	depth 1300 fathoms	1,6°
— - 31	66°35' N.,	55°44' W.,	— 88 —	1,6°
— - 32	66°35' N.,	56°38' W.,	— 318 —	3,9°
— - 78	60°37' N.,	27°52' W.,	— 799 —	4,5°
— - 92	64°44' N.,	32°52' W.,	— 976 —	1,4°

In a previous work (1912 p. 10) it was pointed out that *Cryptolaria conferta* is distinguished from the remaining *Grammaria* species only by differences so slight that they do not by any means warrant generic separation; the bilateral arrangement of the hydrothecæ is not an adequate generic character. — Interesting from a biological point of view is the fact that this typical deep-sea form as a rule develops filiform, root-like basal offshoots, for attachment to the soft bottom; I have, however, once seen a colony which had attached itself to a fragment of the shell of a deep-water mollusc, and had in consequence less highly developed offshoots than most colonies otherwise have.

Grammaria conferta's northern limit of occurrence is moved a considerable distance farther north by the latest finds; otherwise, its distribution is that of a typically abyssal form, and the record of its occurrence in only 88 fathoms' depth far up in Danmark Strait thus comes as a surprise; the more so since the species should generally be noted as a character form for the warmer and deeper waters of the Atlantic. It does not penetrate in over the submarine ridges which form the southern boundary of the Norwegian Sea.

***Grammaria abietina* (M. Sars) Stimpson.**

1851 *Campanularia abietina*, M. Sars, Beretning om en i Sommeren 1849 foretagen Zoologisk Reise, p. 131.

1854 *Grammaria robusta*, Stimpson, Synopsis of the Marine Invertebrata of Grand Manan, p. 9, pl. 1, fig. 3.

The colonies form coarsely built, stiff, irregularly branched rhizocaulomes, in exceptional cases with creeping portions. The hydrothecæ lack the diaphragm, and pass over without constriction into the mother tube; their lower limit is formed by the ring of small chitinous bodies to which the base of the hydranth is attached. The hydrothecæ are tubular, bent to an angle, and have as a rule a slightly everted opening margin. The plane of the aperture itself is normally parallel with the axis of the branch; in forms with particularly short hydrothecæ, the aperture is slightly turned upwards. The hydrothecæ project in most cases far beyond the secondary tubes.

The gonothecæ are closely collected in hermaphroditic coppinæ with highly curved tubes. The

female gonothecæ are much compressed, sessile; the male are stalked, with the stalks pressed in among the female gonothecæ. There are only a small number of almost spherical male gonothecæ in the coppinia; they are freely placed between the surface of the female aggregate and the outer coils of the tubes. The female gonophores are heteromedusoids; the male reduced cryptomedusoids; the fertile colony has nematocysts dimorphously developed.

Forma typica: The upper (adcauline) wall of the hydrotheca projects 1.5–3 times the diameter of the aperture beyond the tubes; the plane of the aperture is parallel with the axis of the branch.

Forma brevicyatha: the free portion of the adcauline wall is 0.5–1 times the diameter of the aperture; the aperture itself is turned obliquely upward.

Material:

Forma typica:

"Ingolf" St.	34	65°17' N.,	54°17' W.,	depth	55 fathoms		
—	- 51	64°15' N.,	14°22' W.,	—	68	—	7,32°
—	- 87	65°02,3' N.,	23°56,2' W.,	—	110	—	
—	- 92	64°44' N.,	32°52' W.,	—	976	—	1,4°
—	- 95	65°14' N.,	30°39' W.,	—	752	—	2,1°
—	- 98	65°38' N.,	26°27' W.,	—	138	—	5,9°
"Thor"		66°43' N.,	15°03' W.,	—	48	—	

Greenland: Davis Strait, depth 66 fathoms (without further details)

Sukkertoppen, on *Boltenia* (— — —)

Godthaab, depth 50–60 fathoms

Hunde-Eiland (without further details)

Cape Tobin, depth 57 fathoms (East-Greenland Expedition)

Jan Mayen: 70°32' N., 8°10' W., depth 470 fathoms

Iceland: 4–5 miles E. of Bakkefjord, — 70 —

5 miles E. of Seydisfjord, — 135 —

64°27' N., 13°27' W., — 150 metres

The Faroe Islands: 61°40' N., 7°40' W., — 135 fathoms

6 miles N. by W. of Kalsö, — 60 —

Forma brevicyatha:

The Faroe Islands: 7 miles N. by E. of Myggenæs point, depth 57 fathoms

6 — N. by W. of Kalsö — 60 —

A rich and well-preserved material of *Grammaria abietina* from the Trondhjem Fjord afforded an opportunity for further study of the species. Its polyps have an oral part with mainly indifferent endoderm cells above the tentacle whorl; the true gastral endoderm exhibits an altogether uniform development. The base of the hydranth is fastened to the wall of the hydrotheca far in between the tubes of the rhizocaulome, by a wreath of small chitinous bodies; this is the only discernible limit between the hydrotheca and its mother stolon, which are otherwise practically of equal breadth. A study of the coppinia (Broch 1917) brought to light several peculiarities. In fertile colonies we find,

in the defensive polyps and elsewhere, large, practically cylindrical nematocysts in addition to the small capsule form which is found in all thecaphores; the nematocysts are thus dimorphous. A remarkable feature about the coppinia is the position of the male gonothecæ, which here appear as stalked, oval to spherical formations between the closely packed female gonothecæ and the outer protective network of the tubes. *Grammaria abietina* thus presents an intermediate stage between types with uniform, hermaphroditic coppiniæ, where the male gonothecæ are wedged in among the female, and those where the male gonothecæ appear singly outside the coppinia or scapus, which has become an altogether female aggregate. The gonophores in *Grammaria abietina* exhibit distinct sexual dimorphism; the female gonophores are heteromedusoids, the male cryptomedusoids. The cryptomedusoid gonophore is, however, here highly reduced, and distinctly presents a transition stage which would, on slight further reduction, become a styloid gonophore.

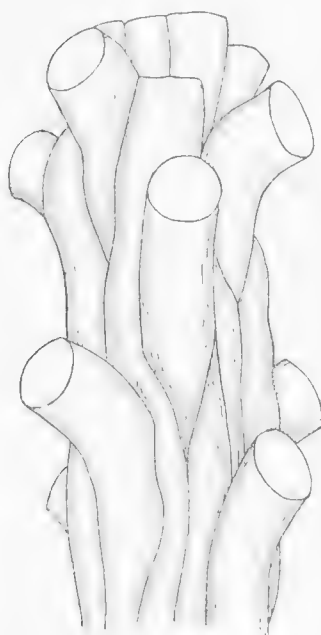


Fig. V. *Grammaria abietina* forma *brevicystha*. Terminal part of a branch. Colony from 7 miles N. by E. of Myggenæs point, the Faroe Islands, 57 fathoms. ($\times 40$.)

From two places at the Faroe Islands we have in the material some very richly developed colonies which, owing to the somewhat divergent character of the hydrotheca, are here noted as representatives of a particular form, forma *brevicystha* nov. In point of habitus, the mentioned colonies differ but little from forma *typica*, they are of equally robust build, and with the same rich ramification; on closer examination, however, one cannot fail to observe the remarkable short hydrothecæ (fig. V). In forma *typica*, the hydrotheca protrudes its distal parts out in front of the stolons so far that the free portion of its upper (adcauline) wall reaches a length of 1.5 to 3 times the diameter of the aperture; in forma *brevicystha*, on the other hand, the corresponding part is only one-half to one diameter in length. This might perhaps by some be regarded as a good specific character. We find however, here and there among the colonies, hydrothecæ presenting the same features as forma *typica*, and, in slightly greater numbers, intermediate forms with lengths filling the interval between the dimensions named. On the other hand, these intermediate forms, and "typica" hydrothecæ occur only in so slight a percentage among the colonies that they exert no influence upon the general character of the colony as a whole. How far we have here to deal with a local variant group, cannot be determined with certainty; that the form can hardly be very common in the northern seas is evident from its rare occurrence in the extensive material now being dealt with, even when this is supplemented by the large collections from Trondhjem Fjord. Still, the form in question cannot be summarily disposed of by noting it under the head of casual single variants, since it occurs in a single colony from one place, but in four remarkably luxuriant ones from the other.

Forma *brevicystha* exhibits certain resemblances to *Grammaria immersa* Nutting; there are, however, so considerable differences observable that the two cannot be confused. The latter species is immediately recognisable from its finer structure, whereas *Grammaria abietina* is a species of very coarse build. The splitting of the tops of the branches (fig. V) in forma *brevicystha* also agrees with *Grammaria abietina*, as distinct from *Grammaria immersa*. A certain likeness to the latter species

again, we find in the shape of the hydrotheca; according to Kramp, (1911 p. 376) the margin of the hydrotheca in *Grammaria abietina* — in contrast to *Grammaria immersa* — always curves outwards slightly; in forma *brevicyatha*, on the other hand, this is only quite exceptionally the case, and by far the greater number of hydrothecæ show no indication of outward curvature in the margin. Kramp has (l. c.) pointed out another feature which is here of more importance. In forma *brevicyatha*, the hydrotheca aperture is almost invariably turned somewhat obliquely upwards, not as in forma *typica*, where the plane of the aperture is parallel with the axis of the branch, or in *Grammaria immersa*,

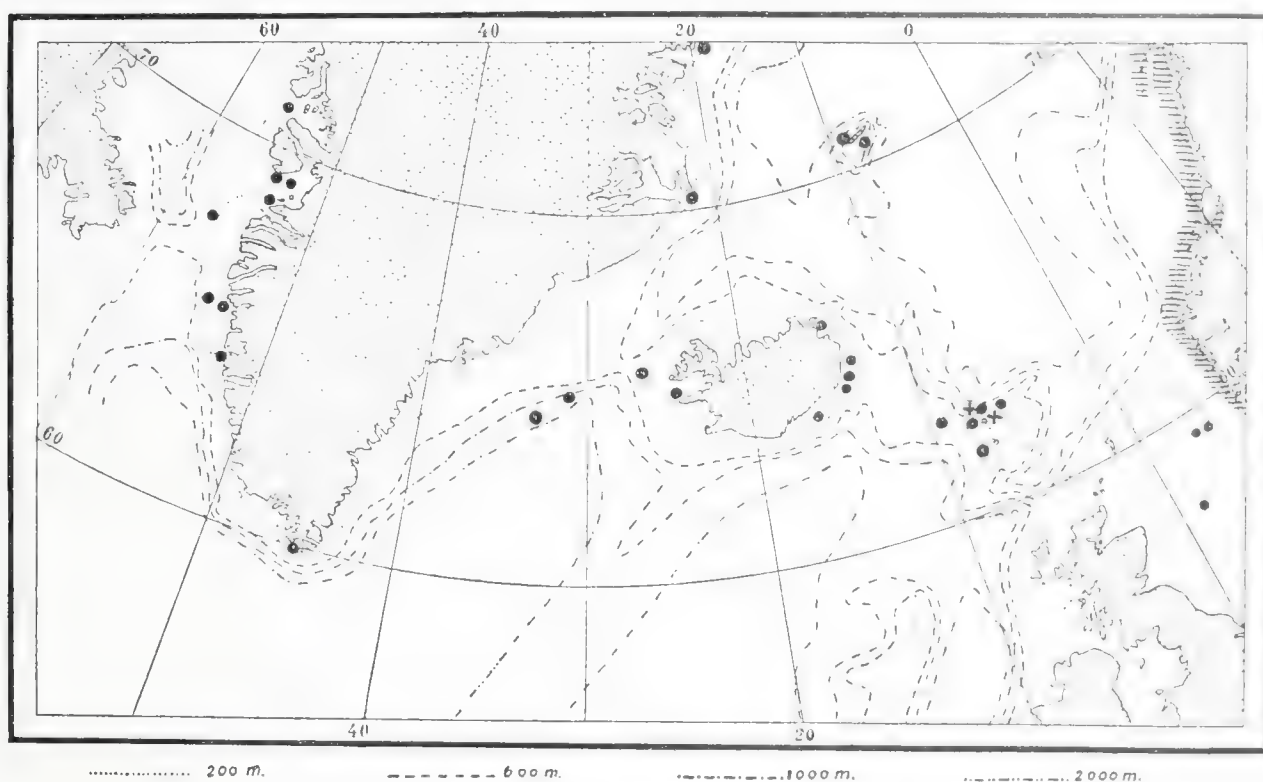


Fig. VI. Localities of *Grammaria abietina* (forma *brevicyatha* +) in the Northern Atlantic.

In the hatched region the literature notes a common, although scattered occurrence.

where the opening is even turned slightly downwards. In forma *brevicyatha*, only the few large hydrothecæ have a plane of aperture parallel with the axis of the branch.

Grammaria abietina is a typical arctic-boreal species, recorded also in a single instance (Billard, 1904 p. 164) from the north of France. It may at times penetrate down to great depths, as for instance at the "Ingolf" St. 92, where it reached 976 fathoms, the greatest depth hitherto recorded for this species. Otherwise it is chiefly found (see fig. VI) in the deeper parts of the littoral regions of the boreal and arctic area. *Grammaria abietina* is also apparently an Atlantic species; it is known from the east coast of North America, to Taimur, but has not hitherto been recorded from about Bering Strait or the Pacific. If, however, it should prove correct that *Grammaria scandens* Stechow is a synonym for *Grammaria abietina*, then it must be classed among the circumpolar species.

Grammaria immersa Nutting.

1901 *Grammaria immersa*, Nutting, Papers from the Harriman Alaska Expedition, p. 178, pl. XXI, figs. 5, 6.

The colonies form stiff, but finely built, irregularly ramified rhizocaulomes. The hydrothecæ pass over into the stolon without marked constriction, their basal limit is formed by the series of small chitinous bodies to which the base of the hydranth is attached. Diaphragm lacking. The hydrothecæ are tubular, highly curved in the distal part, and with no outward curvature of the opening margin. The aperture is normally turned somewhat obliquely down; more rarely, we may find the plane of the aperture parallel with the branch axis. The short freely projecting part has an upper (adcauline) wall in front of the stolons, its length being almost invariably less than half the diameter of the aperture.

The gonothecæ are collected in close (hermaphroditic?) coppinæ, the tubes of which are highly curved, making a close network outside the gonothecæ.

Material:

Iceland: 8 miles E. of Seydisfjord, depth 60 fathoms (labelled *Grammaria abietina*).

Grammaria immersa is an arctic character species; only quite exceptionally does it seem to penetrate into the boreal regions. It is circumpolar, and belongs to the littoral region.

Gen. Lictorella (Allman).

Upright colonies with sympodial growth. The hydrothecæ deep bell-shaped to tubular, often exhibiting a slight asymmetrical development; they have a low yet strong diaphragm, but lack opercular apparatus. Nematothecæ and nematophores lacking. Gastral endoderm of the polyps uniformly developed.

Lictorella pinnata (G. O. Sars) Allman.

1874 *Lafoëa pinnata*, G. O. Sars, Bidrag til Kundskaben om Norges Hydroider, p. 94, tab. 4, figs. 25—28.

1874 — *halecioides*, Allman, Report on the Hydroida . . . Porcupine, p. 471, pl. 66, figs. 1, 1 a.

1888 *Lictorella halecioides* pars, Allman, Challenger Report vol. XIII, p. 35.

nec 1907 *Lafoëa pinnata*, Browne, Hydroids collected by the "Huxley", p. 25.

Upright, single or double pinnate colonies, generally in one main plane, with polysiphonic main stem. The hydrothecæ alternating in two rows along the branches, with a tendency to unilateral arrangement; the hydrothecæ all turned obliquely forward towards the one side (front) of the colony. The hydrothecæ are narrowly bell-shaped, with slightly everted opening margin; transition to stalk gradual. The hydrotheca has a low but strongly developed diaphragm. Stalk generally short, with an oblique furrow on the upper side, at times also a furrow running right round the stalk lower down. The latter furrow runs transversely to the stalk. Polyps with uniform gastral endoderm.

The gonothecæ are collected in an openly constructed scapus on the stem or main branches.

The single gonothecæ are reversed, narrowly conical to almost cylindrical, fastened to the hydrocaulus by a rudimentary stalk at the narrow end; distally, they are furnished with three, more rarely with four or two, round lateral openings, each with a short neck.

Material:

"Ingolf" St. 7	63°13' N.,	15°41' W.,	depth 600 fathoms	4,5°
— - 25	63°30' N.,	54°25' W.,	— 582 —	3,3°
— - 81	61°44' N.,	27°00' W.,	— 485 —	6,1°
"Thor"	61°15' N.,	9°33' W.,	— 872 metres	

Levinsen (1913 p. 287) believes to have found a blind sack in *Lictorella pinnata*; this must doubtless be due to an accidental S-shaped curvature of the polyp, which would not, however, produce

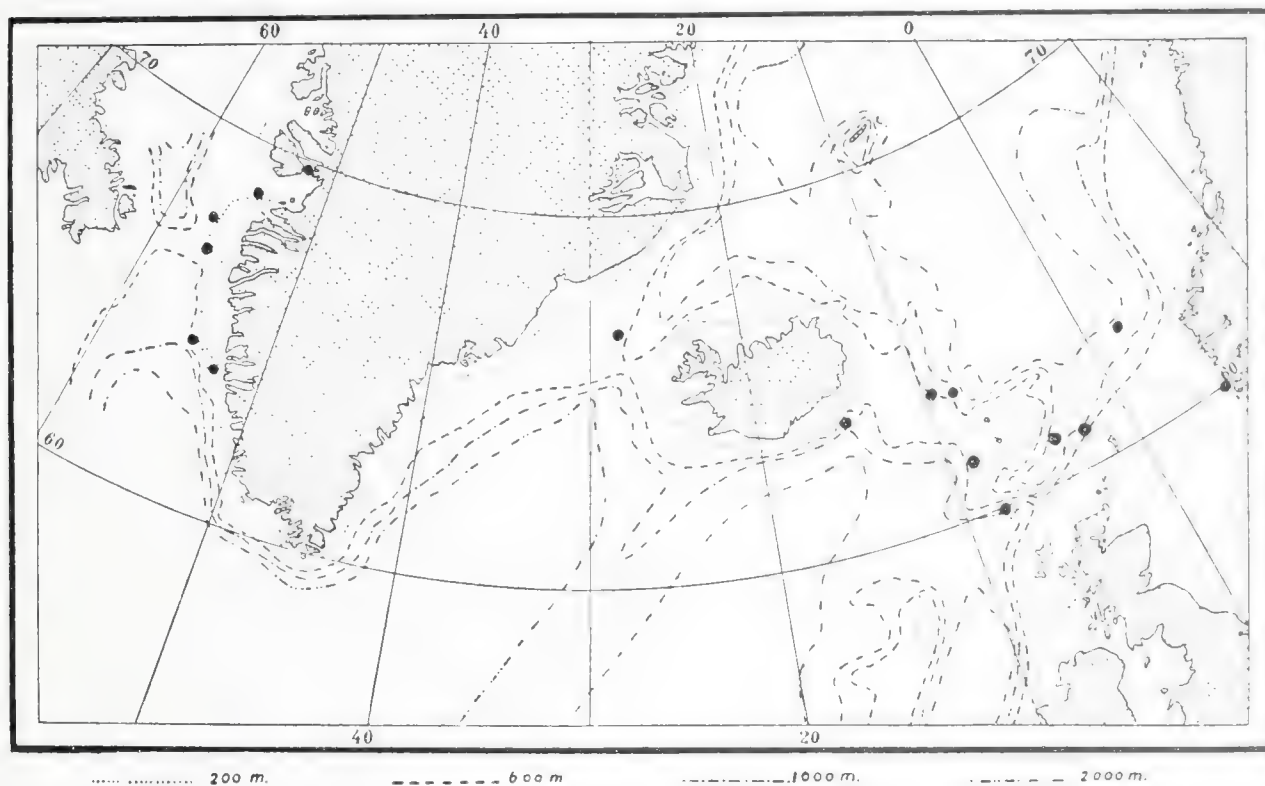


Fig. VII. Finds of *Lictorella pinnata* in the Northern Atlantic.

a blind sack of any real anatomical importance. Microtome sections reveal an entirely uniform gastral endoderm, and I have not been able to find any portion of the endoderm histologically corresponding to the epithelium in the blind sack of *Sertulariidae*. The "blind sack" observed must thus be due to accident.

Lictorella pinnata exhibits a highly remarkable distribution (fig. VII). It belongs to the upper part of the abyssal region, but penetrates as far down as 1300 metres; on the other hand, the species can at times occur right up in the littoral region, and has been met with in the Hardanger Fjord even up at a depth of only 90 metres. Horizontally, the species seems to be quite widely distributed, but the few records from southern seas are unreliable, as the species has here been confused with *Lictorella antipathes* (Lamarck). Pictet and Bedot (1900 p. 16) record it from the Bay of Gas-

cogne. Browne's specimens from the Bay of Biscay (1907 p. 25) on the other hand, should not be included here; from the nematothecæ, they should be ascribed to *Zygophylax*, and are plainly identical with the following species. In the northern Atlantic regions, the species appears to follow the warmer water-masses in their progress through the boreal regions; it has exceptionally been found right up in the Barents Sea.

Gen. *Zygophylax* Quelch.

Upright colonies with sympodial growth. The hydrothecæ are narrowly bell-shaped to tubular, not infrequently somewhat asymmetrical in structure, with a low, but strongly developed radially symmetrical diaphragm. The colonies are furnished with small nematothecæ. The polyps have a uniformly developed gastral endoderm.

Zygophylax biarmata Billard.

1906 *Zygophylax biarmata*, Billard, "Travailleur" et "Talisman", p. 180.

1907 *Lafoëa pinnata*, Browne, Hydroids collected by the "Huxley", p. 25.

1911 *Lictorella Levinseni*, Sæmundsson, Bidrag til Kundskaben om de islandske Hydroider II, p. 86.

nec 1913 *Zygophylax biarmata*, Stechow, Hydroidpolypen der Japanischen Ostküste, p. 114.

Colonies upright, in a plane singly or doubly pinnately branched with polysiphonic main stem; the branches nearly regularly alternating. The hydrothecæ are alternately placed, turning obliquely forward towards the one side (front) of the colony; i. e. with a tendency to unilateral arrangement. The hydrothecæ are mainly tubular, with slightly outward curving margin, narrowing evenly downwards to a stalk of varying length, which has one or two more or less distinctly marked segmentations. The hydrotheca has a well developed low diaphragm. At the base of the hydrotheca stalk, and occasionally elsewhere on the tubes, there are small, cylindrical nematothecæ, attached to the tube or apophyse by a short and often indistinct stalk, generally in one piece. The apophyse has normally a couple of nematothecæ.

The gonothecæ are collected in a primitive, open coppinia (hermaphroditic?) on the stem or main branches; the nematothecæ are more richly developed in the gonotheca aggregate than elsewhere, and appear there in large numbers. The gonothecæ are flattened ovate, with an outward and downward curving neck distally on either side in the transversal plane.

Material:

Iceland, near Vestmännö, depth 510 metres. (Type specimen of *Lictorella Levinseni*).

The first description of this remarkable species is that given by Billard (1906 p. 180) who had, however, only sterile colonies to go upon. It is undoubtedly the same species which Browne records (1907 p. 25) from the Bay of Biscay, though he ascribes it incorrectly to *Lafoëa pinnata* G. O. Sars; the nematothecæ show that it must be a *Zygophylax*, and the exhaustive description very distinctly suggests *Zygophylax biarmata*. Sæmundsson (1911 p. 86) describes the species anew under

the name of *Lictorella Levinseni*, and notes the nematothecæ as among its characteristic features; his colonies, which I have had an opportunity of examining, are fertile, wherefore he was also able to describe the gonosome. This is of a highly peculiar character, and at once demonstrates the incorrectness of Stechow's supposition (1912 p. 114) that the species should be identical with *Zygophylax armata* (Ritchie). Ritchie's species (1907 p. 533) has a typical coppinia, the tubes of which are each furnished with several nematothecæ.

The single gonothecæ in *Zygophylax biarmata* resemble not a little those of *Lictorella pinnata*, the number of opening tubes, however, being apparently in *Zygophylax biarmata* constantly reduced to two, the tubes being at the same time somewhat longer. The single gonotheca stands out freely, but the gonothecæ are closely packed in clusters on the stem or main branches, and between them we find numerous long nematothecæ, remarkably well developed, so that the whole aggregate must be regarded as a primitive coppinia, or rather as something between the open scapus and the coppinia.

There are one or two points which seem to count against the identity of *Lictorella Levinseni* and *Zygophylax biarmata*. Sæmundsson's description rather gives the impression that there are not, normally, a pair of nematothecæ on the apophysis; on closer investigation, however, we are led to the conviction that there are, as a rule, a couple of holes in the periderm showing that nematothecæ have been there, but have fallen off. The colony investigated is the same which Sæmundsson shows in fig. 2 a. — A further difference would seem to exist in the hydrotheca stalks, which in Sæmundsson's specimens are somewhat longer in proportion than stated by Billard. The length of stalk, however, varies considerably in hydroid species, and cannot thus be used as a specific character. And finally, the hydrothecæ in the colony here concerned exhibit a tendency to unilateral arrangement. Sæmundsson does not mention this feature, nor does Billard make any reference to the same in his exposition. It would nevertheless seem, from Billard's figure (l. c. text fig. 8) that the hydrothecæ point obliquely forward towards the one side, the hydrothecæ shown being indicated in oblique projection, with the aperture directed slightly forward towards the observer. Here again then, there is nothing which can be taken as evidence of distinction in species.

The find here recorded extends the known distribution of this deep-sea form considerably towards the north, the species having hitherto been known only from the Bay of Biscay and south of the same. It appears to belong to the abyssal region.

Family Campanulinidæ.

The hydrothecæ are tubular to bell-shaped, sessile or stalked, of the radially-symmetrical type, more rarely with diaphragm. The hydrothecæ are furnished with highly organised closing apparatus, falling in the shape of a roof or a pyramid over the indrawn polyp. The colonies are stolonial or sympodial. The polyps have a conically pointed oral part, and gastral endoderm of uniform organisation.

The generic division of this family has given rise to much dispute, and we even find, that certain writers, such as Schneider (1897) and Bonnevie (1899) regard it as a single genus. The

best exposition of the family is that given by Kramp, who has in two works (1911 and 1913) given a close description, which as regards its main features, is adhered to in the present work. Kramp (1913 p. 14) inclines to the view that the family should be divided into two, a primitive family, *Cuspidellidæ*, where the closing apparatus is formed by the upper part of the hydrotheca wall, and a more highly developed family, *Campanulinidæ*, where the closing apparatus consists of the original roof of the hydrotheca. Kramp's point of view is doubtless highly correct, but as my material is not suited to serve as basis for more detailed exposition, I have merely noted the two mentioned groups as sub-families, otherwise following mainly the generic division established by Kramp (1911 p. 383).

The gonothecæ in several members of the family are of considerable interest, differing only in their greater dimensions from the hydrothecæ — doubtless a primitive feature. This peculiarity is known among the genera of *Stegopoma*, *Cuspidella*, and *Lafoëina*. Unfortunately, very little is known as to the gonophores, but we know that the family comprises the polyp-generation of a number of highly heterogeneous Leptomedusæ, which are distributed by systematists throughout a whole series of families. As, however, the polyps, save for the mentioned characters in the sub-families, exhibit very considerable uniformity, we can hardly, from what we know at present, consent to a further subdivision of the family. We have evidently here to deal with a series of biological divergencies in the medusa generation, particularly calculated to demonstrate the impossibility of establishing, in the present state of our knowledge, any common system for the two generations. The hydroid system cannot here be adapted to the medusa system, which evidently demands thorough investigation of the biological adaptation phenomena in order to give a system which can claim to be considered as fairly satisfactory from a phylogenetic point of view.

Sub-family Cuspidellinæ.

Campanulinidæ with closing apparatus formed by the integrating distal part of the hydrotheca wall.

Gen. *Stegopoma* Levinsen.

Colony creeping or developed to an upright rhizocaulome. The hydrothecæ tubular to narrow bell-shaped, without diaphragm; the closing apparatus consists of two folding membranous parts of the distal hydrotheca wall, which shuts down in a roof-shaped lid over the aperture, between two diametrically opposite teeth. The polyps have uniform gastral endoderm.

Stegopoma plicatile (M. Sars) Levinsen.

1863 *Lafoëa plicatilis*, M. Sars, Bemærkninger over fire norske Hydroider, p. 31.

1874 *Calycella plicatilis*, G. O. Sars, Bidrag til Kundskaben om Norges Hydroider, p. 95.

1893 *Stegopoma plicatile*, Levinsen, Meduser, Ctenophorer og Hydroider, p. 37.

1893 — *caricum*, Levinsen, — — — — — p. 37.

Colonies form upright, irregularly pinnate, polysiphonic rhizocaulomes, sometimes with creeping parts. Hydrothecæ long, tubular, some quite free and short-stalked, others with the one side for part of its extent fused with the stolons; more or less curved, exceptionally with the distal part almost perpendicular to the proximal. Diaphragm lacking. Closing apparatus formed by two folding thin distal portions of the hydrotheca, shutting in a roof over the indrawn polyp between two strong, tooth-like, diametrically opposite parts of the distal portion of the hydrotheca.

The gonothecæ are situated on the branches or on the stalk. They present the appearance of gigantic hydrothecæ, with the same structure of the closing apparatus. The gonothecæ are entirely free, short-stalked, or to a greater or lesser extent attached to the tubes.

Material:

"Ingolf" St. 28,	65°14' N.,	55°42' W.;	depth 420 fathoms,	3,5°
— - 29,	65°34' N.,	54°31' W.;	— 68 —	0,2°
— - 32,	66°35' N.,	56°38' W.;	— 318 —	3,9°
— - 34,	65°17' N.,	54°17' W.;	— 55 —	
— - 35,	65°16' N.,	55°05' W.;	— 362 —	3,6°
— - 126,	67°19' N.,	15°52' W.;	— 293 —	— 0,5°

Greenland: Davis Strait (without further details) depth 80 fathoms

Umanak (— — —)

Ritenbenk (— — —) on *Ega crenulata*

Godhavn (— — —)

Kara Sea, "Dijmphna" (Type specimen of *Stegopoma caricum*.)

This remarkable species shows an astonishing power of altering its appearance. One variant is described by Levinsen (1893 p. 37) as a distinct species, *Stegopoma caricum*, from the fact that it has, at the points of the branches, only three hydrotheca-bearing stolons. This feature, however, as I have previously pointed out (1912 p. 11), cannot be maintained as a specific character, since it may occur in certain branches, while others of the same colony have four or five such tubes near the point; very rarely, again, we may find the number of hydrotheca-bearing tubes reduced to two. It was also pointed out, on the same occasion, that the hydrothecæ can vary, being at times entirely free, at others fused with the tubes. Free hydrothecæ on creeping stolons assume entirely the same appearance as in *Stegopoma fastigiatum* (Alder).

The gonothecæ are mentioned several times in the literature, and have been described by Bonnevie (1899 p. 73) as follows: "Gonangia large, cylindrical with circular opening at the distal end". Kramp, (1913 p. 16) on the other hand, describes them in the same manner as noted in the diagnosis, and gives excellent drawings. In the very extensive material at my disposal from Trondhjem Fjord, where the species is extremely frequent, I have often had occasion to observe the gonothecæ, which in all cases agreed with Kramp's description. It might be imagined that the gonothecæ would exhibit sexual dimorphism; up to the present, however, I have not been able to find anything in support of this idea, and it must thus be presumed that the earlier descriptions were based upon inadequate observation of the gonothecæ.

Stegopoma plicatile is an arctic species, which can nevertheless penetrate into the boreal region (fig. VIII); its occurrence is, however, somewhat of a mystery. The species must be described as circumpolar, having been recorded from Davis Strait through the Norwegian Sea, the Barents Sea, the Kara Sea, and the Siberian Frozen Sea to the Bering Sea and the Sea of Okhotsk. Bathymetrically it is mostly found in the lower part of the littoral region. From this, then, the species should be noted as arctic; as a matter of fact, however, this would not agree with the data from the northern Atlantic regions. There are a couple of isolated finds from the cold area, but the species has not yet been noted either from the east coast of Greenland or from the eastern side of Davis Strait, and

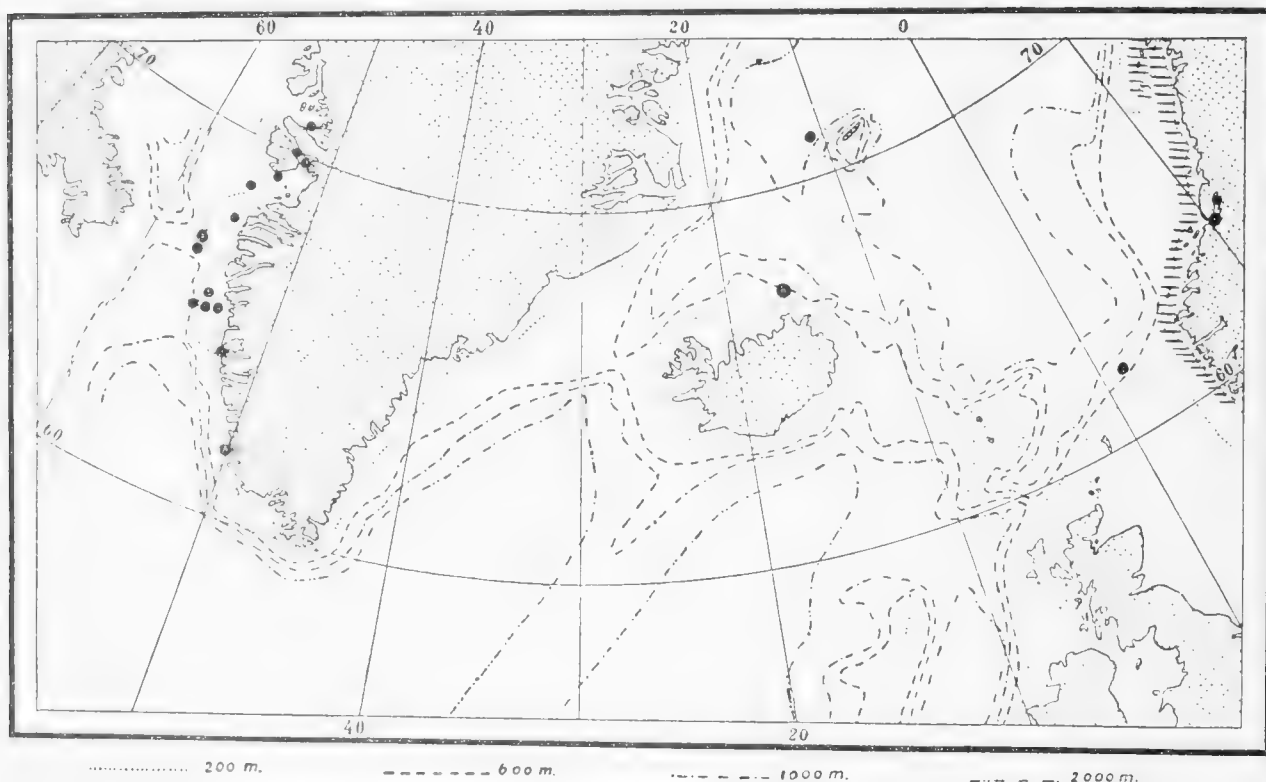


Fig. VIII. The occurrence of *Stegopoma plicatile* in the Northern Atlantic.

In the hatched parts the literature notes a scattered, although common occurrence.

also appears to be entirely lacking in Iceland waters. On the other hand, we find that it is very common along the eastern side of Davis Strait, and — according to the records — along the west coast of Norway; i. e. just in those places where the warmer water layers predominate in the bathymetrical area of its distribution. It may also be noted, in this connection, that the species occurs on the *Lophohelia* reefs in the Trondhjem Fjord, in quantities unknown elsewhere. This occurrence is altogether mysterious in the case of a species otherwise only met with in high arctic waters; one would naturally expect that any extension of its distribution would follow the colder eastern shores, not the boreal western coasts of the continents. It is difficult at present to give any satisfactory explanation of this peculiarity.

Gen. *Cuspidella* Hincks.

Stolonial colonies, with stalkless, sessile tubular hydrothecæ. The closing apparatus is formed by an integrating distal portion of the hydrothecæ, which folds conically over the indrawn polyp; there is no distinct limitation between the closing apparatus and the remainder of the hydrotheca. Nematothecæ lacking.

Cuspidella humilis Hincks.

1863 *Campanularia humilis*, Hincks, M. S., Alder, Supplement to a Catalogue of the Zoophytes, p. 239.

1866 *Cuspidella humilis*, Hincks, On new British Hydroida, p. 298.

Creeping colonies with cylindrical or slightly downward tapering hydrothecæ, passing over without stalk into the stolons. The hydrothecæ are set perpendicularly on the stolons, and are short, with a closing apparatus in which 10—12 segments can be distinguished.

The gonothecæ are set on the stolons, and are of the same shape and appearance as the hydrothecæ, but much larger. The gonophores develop into free medusæ.

Material:

“Thor” 64°16' N., 22°17' W., depth 50 metres

Reykjavik, from the bottom of a well-boat.

This unpretending little species seems to have a fairly wide distribution, and has been met with from the Siberian Frozen Sea down to the Cape Verde Islands. Nevertheless, the few finds lie very wide apart, probably owing to the fact that the species, from its insignificant size, easily escapes observation. Its principal bathymetrical occurrence lies in the middle portion of the littoral region.

Gen. *Lafoëina* M. Sars.

Stolonial colonies with stalkless, sessile hydrothecæ and nematothecæ. The closing apparatus of the hydrotheca is formed by the integrating folding part of the hydrotheca, and passes over without distinct limitation into the same; it closes conically over the indrawn polyp. The nematotheca has a distal laterally situated aperture.

Hadži points out in a letter that there are possibly two genera concealed under this definition. According to the drawing given by G. O. Sars, of *Lafoëina tenuis* (1874, tab. V, fig. 3), there seems to be a diaphragm occurring in this species at the junction of the hydrotheca and stolon. Levinsen (1893 p. 40) was not able to find any diaphragm in *Lafoëina maxima*, and I have likewise been unable to find any such here; my material, however, is of such a nature that a negative result cannot be considered as of decisive importance. Should it be found that certain species have a diaphragm, while others lack the same, it will then doubtless be most correct to divide the genus, and a further investigation of *Lafoëina tenuis* must then decide which of the two groups is to retain the name *Lafoëina*.

***Lafoëina maxima* Levinsen.**

1893 *Lafoëina maxima*, Levinsen, Meduser, Ctenophorer og Hydroider, p. 182, tab. IV, figs. 9—12.

The colonies form upright, robust rhizocaulomes, often combined with creeping parts, which spread out in plates over the underlayer. The closely set hydrothecæ are cylindrical, somewhat irregularly bent, with their outer portion nearly perpendicular to the branch axis. The hydrotheca has a conically closing distal portion, exhibiting no distinct limitation from the remaining part of the same. Between the hydrothecæ are the nematothecæ, which are very numerous, and closely packed; they are slender, cylindrical, somewhat irregularly curved, with a distal, laterally situated oval aperture, in which are some few large nematocysts.

The gonothecæ are wedged in between the nematothecæ and the hydrothecæ; they differ neither in form nor in size from the hydrothecæ, and their nature can thus as a rule only be determined from section preparations.

Material:

"Ingolf" St. 29	65°34' N.,	54°31' W.;	depth 68 fathoms	0,2°					
— - 34	65°17' N.,	54°17' W.;	— 55	—					
—	Holstensborg Harbour		— 30	—					
Greenland: Egedesminde						(without further details)			
Store Hellefiskebanke,	depth 24 fathoms								
—	north of Holstensborg	(— — —)							Levinsen's type- specimens
Holstensborg		(— — —)							
Godthaab,	depth 60—70 fathoms								
Davis Strait	— 100 —								
Iceland: Hrútafjörð,	depth 45 metres.								

Lafoëina maxima is a typical arctic species, belonging to the upper half of the littoral region (fig. IX). The most southerly records of its occurrence are from Godthaab in Greenland, and Hrútafjörð in Iceland; in the Norwegian waters it has hitherto only been met with in Ramfjorden, near Tromsø (about 69°30' N.)

Gen. *Campanulina* van Beneden.

Colonies with sympodial growth and stalked, radially symmetrical hydrothecæ. The closing apparatus of the hydrotheca is formed by the distal folding portion of the hydrotheca wall, and goes over into the same without sharp limitation. When folded down, the closing apparatus covers the hydrotheca with a conical lid. The gonothecæ differ in appearance from the hydrothecæ.

Kramp, in his exposition (1911 p. 383) merely draws attention to the stalked hydrothecæ of the genus as opposed to the sessile in *Cuspidella* and *Lafoëina*. Further, secondary characters are, it would seem, here also to be found in the growth types of the colony, whether stolonial or sympodial.

Thus the two last-named genera have, as far as we know, always stolonial colonies, whereas in *Campanulina* they are invariably sympodial.

Campanulina turrita Hincks.

1868 *Campanulina turrita*, Hincks, A History of the British Hydroid Zoophytes, p. 190, pl. 36, fig. 2.

Upright sympodial colonies with monosiphonic hydrocaulus, ringed throughout. The stem slightly zigzag. Stem and branches are divided into slightly pronounced internodia, bearing distally

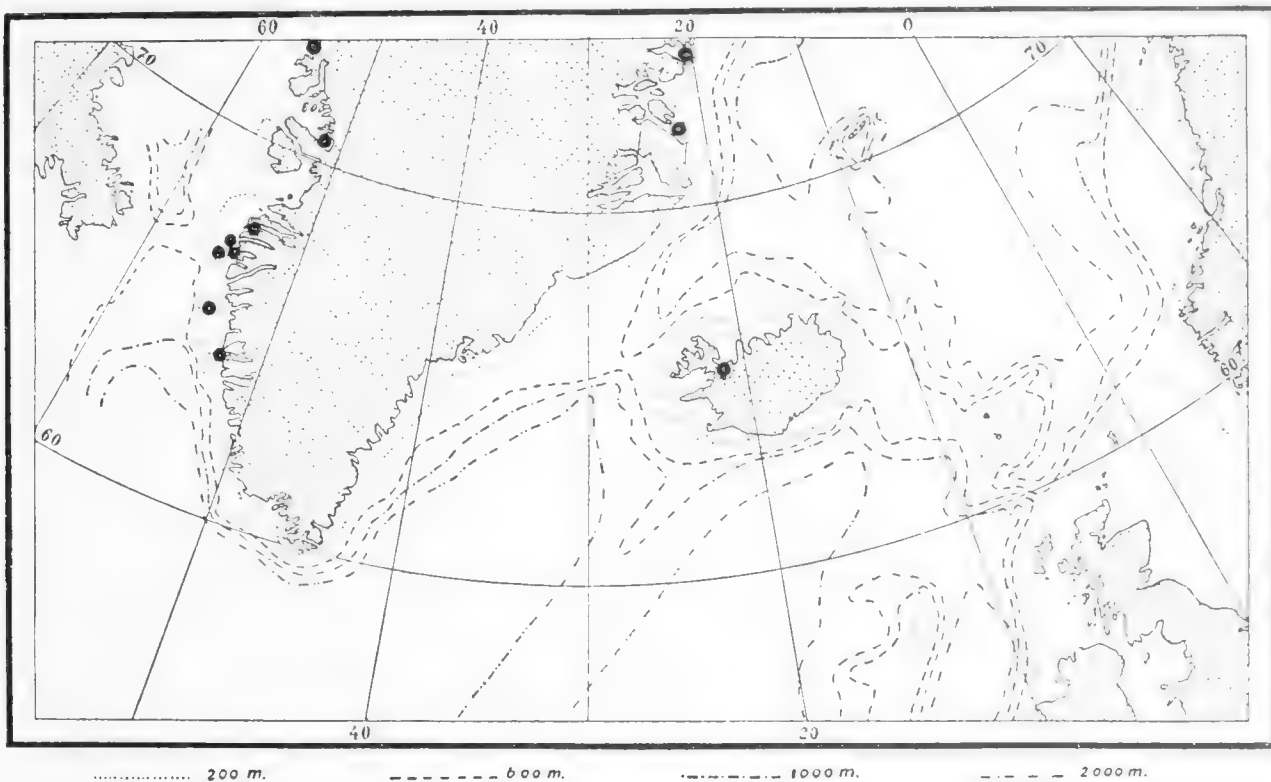


Fig. IX. Finds of *Lafoëina maxima* in the Northern Atlantic.

an apophysis and one or two short-stalked hydrothecæ; from the apophysis the next internodium projects. At irregular intervals, one of the hydrothecæ is replaced by a branch, so that the colonies assume an irregularly bushy appearance. The hydrothecæ are fairly large, and when closed, about twice as long as broad; they are practically cylindrical, with evenly curved proximal part. Diaphragm lacking. Closing apparatus passes over without distinct limitation into the lower portion of the hydrotheca wall; it closes conically over the indrawn polyp.

The gonothecæ are set upon short, ringed stalks, projecting from the stem or branches beside the hydrotheca stalks. The gonothecæ are small, slender, reversed conical or cylindrical with gradually tapering basal part; they are cut off transversely at the distal end. The gonophores develop (according to Hincks) into free medusæ.

Material:

"Ingolf", Holstensborg Harbour, on algæ.

Greenland: Smallesund near Egedesminde, on algæ.

In one of the colonies from Smallesund, a distinct renovation is discernible; unfortunately, it cannot be determined with certainty whether the primary individual has been a hydrotheca or a gonotheca, but the size would seem to suggest a primary hydrotheca. We have in this case not a heteromorphic renovate, as the renovate is a fully developed, stalked hydranth. The instance in question calls to mind Levinsen's description (1892) of renewal of individuals in certain *Campanulariidae*.

The new find of *Campanulina turrita* from Greenland is highly interesting. Since Hincks found the species in Ireland it has only been recorded by Levinsen (1893 p. 181) at Egedesminde; from Holstensborg Harbour, the "Ingolf" brought home a whole series of finely developed colonies.

Sub-family Calycellinæ.¹

Campanulinidae with closing apparatus formed by the original roof of the hydrotheca.

Gen. Calycella (Hincks).

Creeping colonies with tubular hydrothecæ, the closing apparatus sharply marked off from the hydrotheca itself, and easily falling off. The closing apparatus is formed by the peripheral parts of the original hydrotheca roof, the central portion of which is discarded; the closing apparatus is a folding membrane folding conically over the indrawn polyp. The hydrotheca lacks diaphragm.

Calycella syringa (Linné) Alder.

1767 *Sertularia syringa*, Linné, Systema Naturæ, ed. 12, vol. 1, p. 1311.

1860 *Calicella syringa*, Alder, Descriptions of a Zoophyte . . ., p. 73.

1868 *Lafoëa pygmaea*, Alder, pars, Hincks, A History of the British Hydroid Zoophytes, p. 205.

Colonies creeping. Hydrothecæ tubular, often somewhat bent, with slightly outward curving opening margin; they are borne upon stalks, short or long, furnished with a varying number of rings. The closing apparatus is sharply marked off from the thicker wall of the hydrotheca, and easily falls off; it consists of an entire membrane, which folds down on definite lines, forming a conical roof over the indrawn polyp.

The gonothecæ are attached by short, ringed stalks to the stolons. They are oval, smooth. Gonophores heteromedusoid.

Material:

"Ingolf" St. 95 65°14' N., 30°39' W.; depth 752 fathoms, 2,1°

"Thor" 64°16' N., 22°17' W.; — 50 metres

— 64°02' N., 22°33' W.; — 34 —

¹ As the genus *Campanulina* belongs to the preceding subfamily, the present subfamily should not be called *Campanulininæ* but better *Calycellinæ*.

Greenland: Godhavn (without further details)

Egedesminde (— — —)

Store Hellefiskebanke off Holstensborg, depth 18—20 fathoms

Sukkertoppen, on *Boltenia* and on algæ (without further details)

Davis Strait, depth 80—100 fathoms (— — —)

Iceland: Seydisfjord — 6 —

Vadlavik — 80 —

Röðefjord — 95 metres

Djupivogur — 8 fathoms

Vestmanö — 10—15 —

Skagi — 40 metres

Hvalfjord — 46 —

Stykkisholm — 30 fathoms

Önundarfjord — 10 —

Skjalfandibugt — 28 —

Breðebugt 65°17,5' N., 23°32' W., depth 7—12 fathoms

6 miles W. of Iceland (without further details)

The Faroe Islands: 6 miles N. by W. of Kalsö, depth 60 fathoms

Deep hole at north point of Nolsö, depth 100 fathoms.

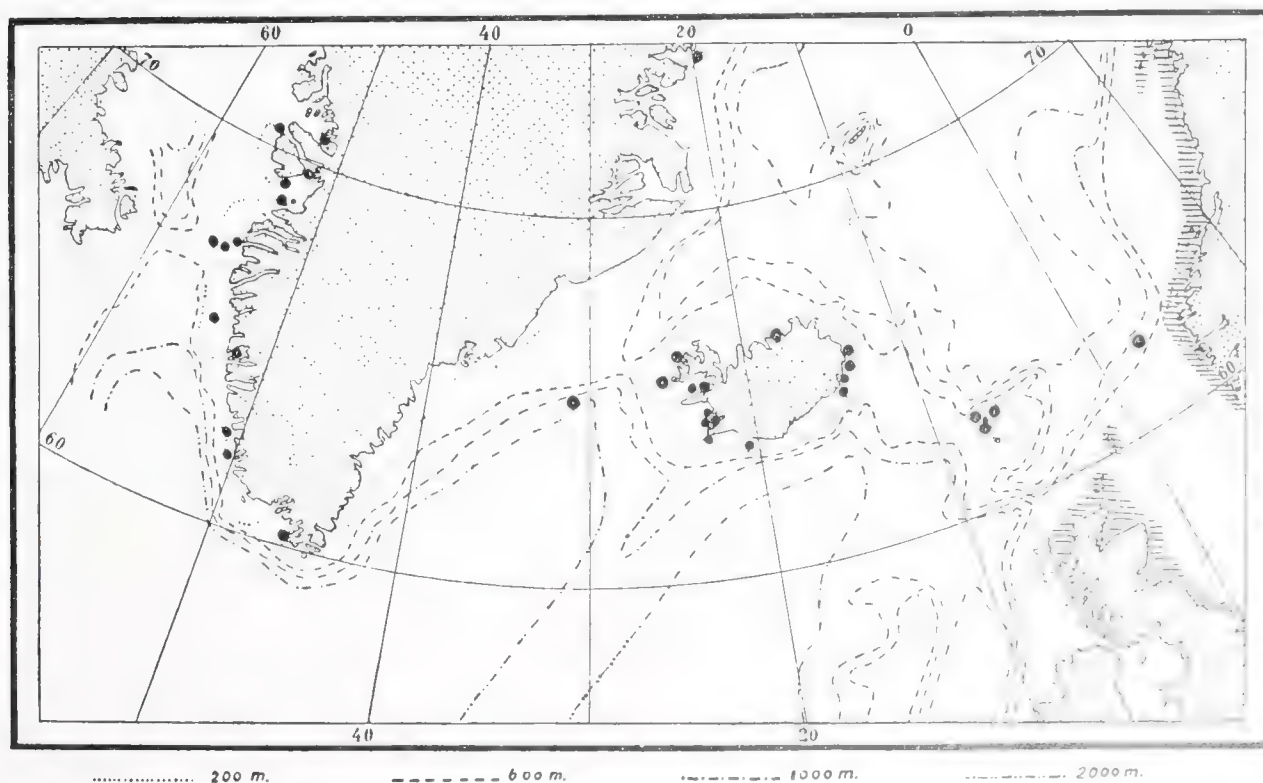


Fig. X. The distribution of *Calycella syringa* in the northern Atlantic.
In the hatched regions the literature denotes a common occurrence.

It is evidently this species which is partly mentioned under the term *Lafoëa pygmæa*; according to Hincks (1868 p. 205) some of Alder's original drawings show a conical lid in this species, which at once shows that Alder's specimens, or at any rate some of them, must have been *Calycella syringa*. That *Lafoëa pygmæa* is here only partly noted as synonymous with this species, is, as indicated under *Lafoëa gracillima*, owing to the fact that several writers at any rate have recorded creeping colonies of the latter species under the same name.

Calycella syringa appears to be a wholly cosmopolitan species, which has been met with in all seas. Its bathymetrical area is very extensive, ranging from about 6 metres down to nearly 1500; it should nevertheless be observed that its occurrence in the abyssal region is exceptional, its chief area of distribution being restricted to the middle and upper parts of the littoral waters. Within the area investigated (fig. X) we find that it is apparently lacking along the greater part of the east coast of Greenland, where it is first met with far to the north, about 76° N. Its occurrence under high arctic conditions is altogether scattered, save where an intermixture of warmer water is discernible.

Gen. *Tetrapoma* Levinsen.

Stolonial colonies with tubular or narrowly bell-shaped hydrothecæ without diaphragm. Closing apparatus formed by the original roof of the hydrotheca, and separated by a marked limitation from the thicker hydrotheca wall; it consists of (four) separate triangular plates, each attached in a sinus, between as many hydrotheca teeth. The polyps have a uniformly developed gastral endoderm, and lack outer ectoderm lamellæ.

In a previous work (1909 p. 165) I united this genus with *Lovenella*. Kramp (1911 p. 383) separates them again as two genera, chiefly, it would seem, on account of the number of plates in the lid. This feature can hardly be called important as a generic character; there is, however, another distinguishing feature of greater significance, which renders it necessary to separate the two genera. Hincks (1868 p. 178) especially mentions in *Lovenella clausa* (Lovén) the presence of a diaphragm, a formation which does not appear to be found in *Tetrapoma quadridentatum*, and which warrants generic distinction. Secondly, this separation is supported by the fact that *Tetrapoma* has stolonial colonies, while those of *Lovenella* are sympodial.¹

Levinson (1913 p. 283) observes in a footnote, regarding *Tetrapoma*, "This genus must, no doubt, be united with *Thyroscyphus*". In this I am for several reasons unable to concur. In the first place, *Thyroscyphus* has a distinct diaphragm, and hydrothecæ of bilateral structure; in the second, the structure of the polyp also is entirely different. *Thyroscyphus*, with its ectoderm lamellæ and incipient blind sack formation, as also the differentiated gastral endoderm, exhibits closer relationship with *Sertulariidae*, and should probably far rather be considered as a primitive genus of this family.

Tetrapoma quadridentatum (Hincks) Levinson.

1874 *Calycella quadridentata*, Hincks, On deep-water Hydroida from Iceland, p. 149, pl. 8, figs. 17—20.

1893 *Tetrapoma quadridentatum*, Levinson, Meduser, Ctenophorer og Hydroider, p. 180.

¹ Comp. also *Lovenella corrugata* Thornely (Broch 1914 p. 32).

Creeping colonies with tubular hydrothecæ. The hydrotheca stalk is irregularly, but distinctly ringed or spirally coiled. The hydrothecæ pass over evenly into the stalk, they are somewhat expanded at the base, then tapering slightly upwards, to expand again a little towards the opening margin, which curves somewhat outwards. The opening margin itself has four low, but distinctly discernible teeth, and has four triangular opercular plates fastened between them.

The gonothecæ are unknown.

Material:

Greenland: Egedesminde, depth 30—50 fathoms.

Scattered specimens of this high-arctic species have been found at West Greenland, Spitzbergen, in the Murman Sea, the Barents Sea, the White Sea, the Siberian frozen Sea and the Sea of Okhotsk, and must thus doubtless be referred to the circumpolar species. It belongs to the middle parts of the littoral region.

Family series *Haleciina* nov.

Family *Haleciidæ*.

The hydrothecæ are radially symmetrical and very small, at times practically altogether disappearing; they have as a rule a basal cavity, often marked off from the hydrotheca itself by a diaphragm. The hydranths are large, and cannot be drawn quite into the hydrothecæ. They have a conical proboscis, and their gastral endoderm falls into two divisions, answering to the fore-stomach and stomach of the polyp, which as a rule are separated by a limit indicated by a more or less marked ring furrow round the body of the polyp. The basal part, the stomach, forms the digestive portion. The polyps are radially symmetrical in structure. The colonies are stolonial or sympodial, with simple or derived growth of the tips.

Gen. *Halecium* Oken.

Creeping stolonial, or upright sympodial colonies with small radially symmetrical hydrothecæ with basal cavity. The diaphragm can be present or lacking. Nematothecæ and nematophores lacking. The gonophores are developed in gonothecæ.

The *Halecium* colony, in species with polysiphonic stem, often presents a peculiar appearance, differing greatly from that of other hydroid colonies, as the polysiphonic main stem, which is generally very strongly developed, most frequently presents the same impression as an altogether irregularly branched rhizocaulome, while the outer parts of the branches almost always exhibit regular ramification. *Halecium minutum* Broch especially, seems in some respects to take up a remarkable and exceptional position; according to Kramp's observations (1913 p. 5) it can at times exhibit large colonies of composite structure with rhizocaulome-like polysiphonic main stem and main branches, while otherwise, the species normally presents small, monosiphonic colonies proceeding from a network of

creeping stolons. This thus confirms, as Kramp points out, the doubts which have been expressed by certain previous writers as to the fundamental importance of the structure of the colony for hydroid systematics, and partly effaces the limit between creeping species and species with upright, composite colonies.

The genus *Halecium* is characterised by the lively renovation of its hydranths. This should, it would seem, be explained as due partly to the lack of special defensive individuals, partly to the minimal size of the hydrothecæ, and finally also to the large dimensions of the polyps, which probably render them particularly attractive to creatures preying upon hydroids generally. The marked renovation activity often leads to the formation of whole piles of hydrothecæ, or apparently small branches, for which Schydłowski (1901) has introduced the term "pseudohydrocauli".

Not infrequently also, heteromorphotic renovates may be observed; I have previously (1909 p. 151) noticed that the formation of gonothecæ as heterorenovates is characteristic of the male in *Halecium ornatum* Nutting. Heteromorphotic renovates of a more accidental nature will be noted later on in several species; these are of great interest, since renovates of this kind have, according to Hadži (1915) only been met with in nature among *Halecium* and *Synheciidae*. The question has, however, been too little studied as yet to permit of our drawing further conclusions from this, but the point should be kept in mind, until it has been fully cleared up.

***Halecium halecinum* (Linné) Oken.**

1758 *Sertularia halecina*, Linné, Systema Naturae, Ed. 10, p. 809.

1815 *Halecium halecinum*, Oken, Lehrbuch der Naturgeschichte, vol. 1, p. 91.

Stiffly built, as a rule doubly pinnate colonies with polysiphonic main stem. The branches are as a rule pinnately ramified in the same plane as the main stem, or the colonies may, more rarely, assume an irregular bushy shape. The minor branches are divided up into regular internodia, the length of which is about twice the distal breadth. The primary hydrothecæ are low, often almost like a mere opening in the branch apophysis at the distal end of the internodium. The secondary hydrothecæ are small, with a large basal cavity, generally somewhat asymmetrically developed, and having the basal part of its adcauline wall highly concave. The hydrothecæ are somewhat broader at the aperture than at the well-developed, fairly strong diaphragm; the opening margin is not curved outward.

The gonothecæ are large, and proceed from the apophysis at the base of the primary hydrothecæ. The males are narrowly cylindrical to elongated oval, tapering below, distally cut off transversely, or more often broadly rounded. The female gonothecæ have a distal laterally placed aperture with a pair of hydranths; the aperture is furnished with a short cylindrical neck, and situate normally at the distal end of the hydrothecæ; more rarely, the distal part of the gonotheca may be domed somewhat forward, so that the opening is a little below the point. The gonotheca is slender, almost entirely straight or slightly convex on the side opposite the pair of hydranths, and tapering evenly downwards.

Material:

"Ingolf" St.	7,	63°13' N.,	15°41' W.,	depth 600 fathoms,	4,5°
—	-	9,	64°18' N.,	27°00' W.,	— 295 — 5,8°
—	-	54,	63°08' N.,	15°40' W.,	— 691 — 3,9°
"Thor"		63°30' N.,	20°14' W.,	— 80 metres —	[labelled <i>Halecium halecinum</i> , <i>H. Beanii</i> and <i>H. labrosum</i>].

Greenland: Cape Tobin, depth 57 fathoms (East Greenland Expedition).

Iceland: Vadvík (depth not stated)

Vestmanna, depth 30—40 fathoms [labelled *Halecium halecinum* and *H. Beanii*]

10 miles W. of Akranes (depth not stated) [labelled *Halecium Beanii*].

Between Iceland and The Faroe Islands, depth 192 fathoms (without further details)

The Faroe Islands: 6 miles N. by W. of Kalsö, depth 60 fathoms

Stokken 2 miles in S.22E., — 55 —

Deep hole at north point of Nolsö, depth 100 fathoms.

Glyversnæs near Thorshavn, on red algæ.

Borönæs 13 miles in N.75W., depth 30 fathoms.

Halecium halecinum is generally of somewhat coarser build than *Halecium Beanii*, but a good deal finer than *Halecium scutum*; it is often extremely difficult to distinguish these species one from another, especially when the colonies assume an altogether irregular form, which the males in particular are inclined to do. The female gonothecæ in *Halecium halecinum* will, in their normal shape, with the quite terminal lateral opening, hardly be confused with normal individuals of the other species, but when, as not infrequently occurs, the distal portion of the gonotheca is domed forward, so that the aperture is found somewhat below the point on one side of the gonotheca, the identity is by no means easy to determine. True, *Halecium scutum* is in most instances of far coarser build than the two others, but the variation in dimensions is within each of the three too great to permit the fixing of proper size limits; they would be found to overlap considerably. A useful general character for *Halecium halecinum* is the asymmetrical development of the basal cavity in the secondary hydrotheca (fig. XI); the basal part of the adcauline wall is more strongly developed, and highly curved, so that the hydrotheca axis thus diverges widely from the branch. On the other hand it must be remarked that the hydrotheca aperture is perpendicular to the longitudinal axis, a feature whereby the species is distinguished from *Halecium Beanii*.



Fig. XI. *Halecium halecinum*. Internode with hydrothecæ. From the Faroe Islands at north point of Nolsö. ($\times 60$).

Halecium halecinum has an extremely wide area of distribution, and is very common right up in the Mediterranean; it has also been recorded from waters south of the Equator. In the northern waters, the species appears as a boreal character form, with warmer tendency (fig. XII) and is mostly met with in the middle part of the littoral region; at times, however, it may penetrate right down into the abyssal, as at the "Ingolf" St. 54, where it was taken in a depth of over 1300 metres. In purely arctic waters, it is very rare, and records of its occurrence there must be treated as doubtful, as it

has evidently on several occasions been confused with *Halecium scutum*. The same applies in part to certain of the records from southern waters, where the species has undoubtedly often been mixed up with *Halecium Beanii*.

Halecium Beanii Johnston.

1847 *Halecium Beanii*, Johnston, A history of the British Zoophytes p. 59, pl. 9, figs. 1-2.

Upright densely built colonies with polysiphonic, fairly robust main stem, and monosiphonic, pinnately ramified outer branches; the ramification of the colony presents as a rule a main plane. The

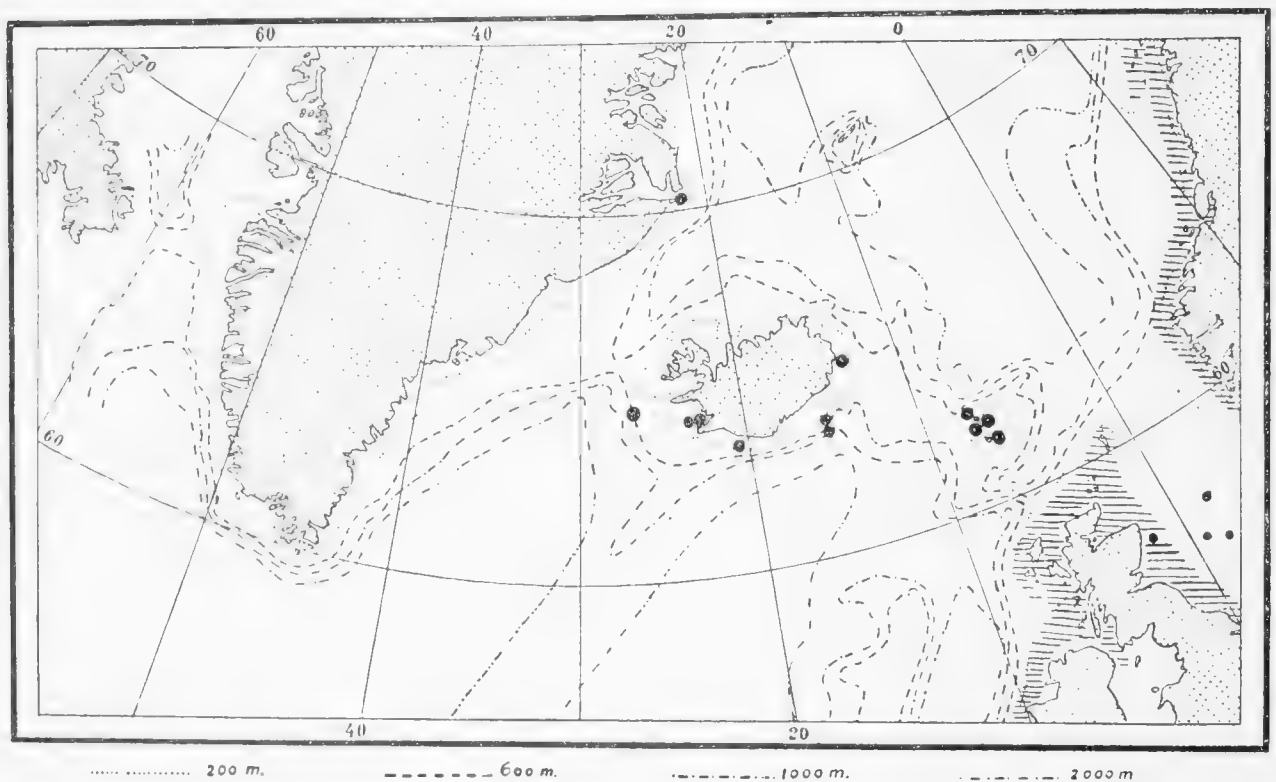


Fig. XII. The distribution of *Halecium halecinum* in the northern Atlantic.

In the hatched regions the literature denotes a common occurrence.

minor branches are divided into slender regular internodia; the distally situate, hydrotheca-bearing apophyse is almost of the same breadth as the branch itself, and sharply defined; the length of the internodium is about 2-2.5 times the distal breadth (including apophyse). The hydrothecæ small, bounded on the lower side by a slight diaphragm. The primary hydrothecæ are hardly more than an aperture in the apophyse, and the hydranth is evidently very soon renewed; the basal chamber of the secondary hydrotheca is symmetrical, with a distinctly marked basal expansion; above this the hydrotheca stalk is narrowest, its breadth increasing slightly from there until it passes over into the somewhat obliquely set hydrotheca; the latter is a little broader at the aperture than at the diaphragm; opening margin not outward curved.

Gonothecæ of medium size, proceeding from the apophyse of the primary hydrothecæ. The

males are very elongated oval, the females elongated oval to sausage-shaped, highly curved, with a short cylindrical neck in the middle or on the basal half of the gonotheca, and on the concave side of the same. Opening margin level; in the opening itself a pair of hydranths.

Material:

"Thor" 63°30' N., 20°14' W., depth 80 metres.

The Faroe Islands: Borönæs 13 miles in N.75W., depth 30 fathoms.

On a previous occasion (1913 p. 13) I stated that *Halecium Beanii* should be regarded as a variant of *Halecium halecinum*; further investigations have, however, shown that this is not correct, even though the two species, more particularly in a sterile state, may often enough be difficult to distinguish. Fertile female colonies are not easily confused, the form of the gonothecæ being typically different; in comparison with the following species it should be noted that the aperture in *Halecium Beanii* lies roughly in a line with the basal and distal end of the gonotheca, and that the neck axis closely approaches, if not entirely coinciding with, this line. (Fig. XIII). The branches are, in *Halecium Beanii*, often slenderer than in *Halecium halecinum* and *Halecium scutum*, and the apophyse is somewhat more marked; in addition, the basal chamber of the secondary hydrotheca is symmetrically developed, and not asymmetrical as in *Halecium halecinum*; finally also, the oblique position of the hydrotheca aperture as towards the axis serves to distinguish *Halecium Beanii* from the two related species mentioned.



Fig. XIII. *Halecium Beanii*.

a. Internode with hydrothecæ. b. Gonotheca ♀. From the Faroe Islands, Borönæs 13 miles in N.75W. $\times 60$.

The geographical data for *Halecium Beanii* are extremely unreliable as regards the northern waters; the species is, as I have frequently been able to perceive, often confused with *Halecium scutum* in arctic, with *Halecium halecinum* in boreal areas. In all probability, it is a heat-loving form, which exceptionally penetrates into the northern waters.

***Halecium scutum* Clark.**

1876 *Halecium scutum*, Clark, Report on the Hydroids Alaska and the Aleutian Islands, p. 210, pl. 10, figs. 13—14.

Robust colonies with polysiphonic main stem. The outermost small branches exhibit an almost regular pinnate ramification in the same principal plane as that in which the branching of the colony falls; more rarely, the colonies may be quite irregularly bushy. The minor branches are divided up into internodia, the length of which is about twice the distal breadth (apophyse included). The primary

hydrothecæ are low, often hardly more than an opening in the apophyse, which is distally placed, and distinctly marked. The secondary hydrothecæ are likewise small, with a fairly large basal chamber, which is almost always symmetrically developed. The hydrothecæ have a thin, but well-developed diaphragm; they expand towards the aperture, but have no outward curving margin.

The gonothecæ are small, and attached to the apophyse at the base of the primary hydrothecæ. The males are cylindrical to elongated oval, tapering downwards, broadly rounded distally, or cut off transversely. The female gonothecæ have a laterally placed opening with a pair of hydranths; the opening margin has on its inner (adthecal) side a short, broadly lingueform protuberance. The gonotheca openings are situated between the middle and the distal end of the gonotheca, rarely quite distally. The gonotheca is often somewhat irregularly bent.

Material:

"Ingolf" St. 31, 66°35' N., 55°54' W., depth 88 fathoms 1,6°

— - 34, 65°17' N., 54°17' W., — 55 —

Greenland: Sukkertoppen (without further details)

Davis Strait, depth 100 fathoms (without further details) [labelled *Halecium Beanii*]

Iceland: Vadvík, (depth not stated) [labelled *Halecium Beanii*]

Between Iceland and The Faroe Islands: 63°15' N., 9°35' W., depth 270 fathoms [labelled *Halecium Beanii*]

The Faroe Islands: Deep hole at north point of Nolsö, depth 100 fathoms

61°40' N., 7°40' W., depth 135 fathoms

Kara Sea: "Dijmphna" [labelled *Halecium Beanii*].

It is not without a certain doubt that we can admit *Halecium scutum* as a distinct species and not as an arctic form of *Halecium halecinum*. From a geographical point of view, as also with regard to most of the variational features, it stands in almost exactly the same relation to the last-named species as the arctic forms of several other more or less cosmopolitan hydroids. And it is also *Halecium scutum* which has formerly (Broch 1909 p. 144) been noted as forma *gigantea* of *Halecium halecinum*.

A comparison of the two species reveals various points of resemblance. Bonnevie's statement (1899 p. 57) "ramification in all planes" as a characteristic feature cannot be admitted; it applies as a matter of fact far more to the exceptions, the great majority of the colonies exhibiting a decided main plane in which the ramification takes place. On the other hand, the short and broad internodia (fig. XIV a) are typical, and differ not a little from *Halecium Beanii*, with which the species has especially been confused. The secondary hydrothecæ differ normally from *Halecium halecinum* in having a symmetrical and proportionately lower basal cavity, and from *Halecium Beanii* in having the plane of the aperture perpendicular to the longitudinal axis. — The frequent confusion of *Halecium scutum* with *Halecium Beanii* is due to the great variability of the female gonothecæ (figs. XIV b—h) which not infrequently (c—f) resemble strongly those of the latter species. We should, however, note that in *Halecium scutum* the aperture and its short neck are as a rule obliquely placed, diverging widely from the line between the stalk of the gonotheca and its top; in addition, the gonotheca has an

adthecal lingueform protuberance which is lacking in *Halécium Beanii*. The extreme variants in the other direction, (*b* and *c*; *h*) are markedly suggestive of broadly built gonothecæ in *Halécium halecium*, so that fertile colonies likewise may here often be confused. The illustration *c* shows a gonotheca which has arisen as a heteromorphotic renovate.

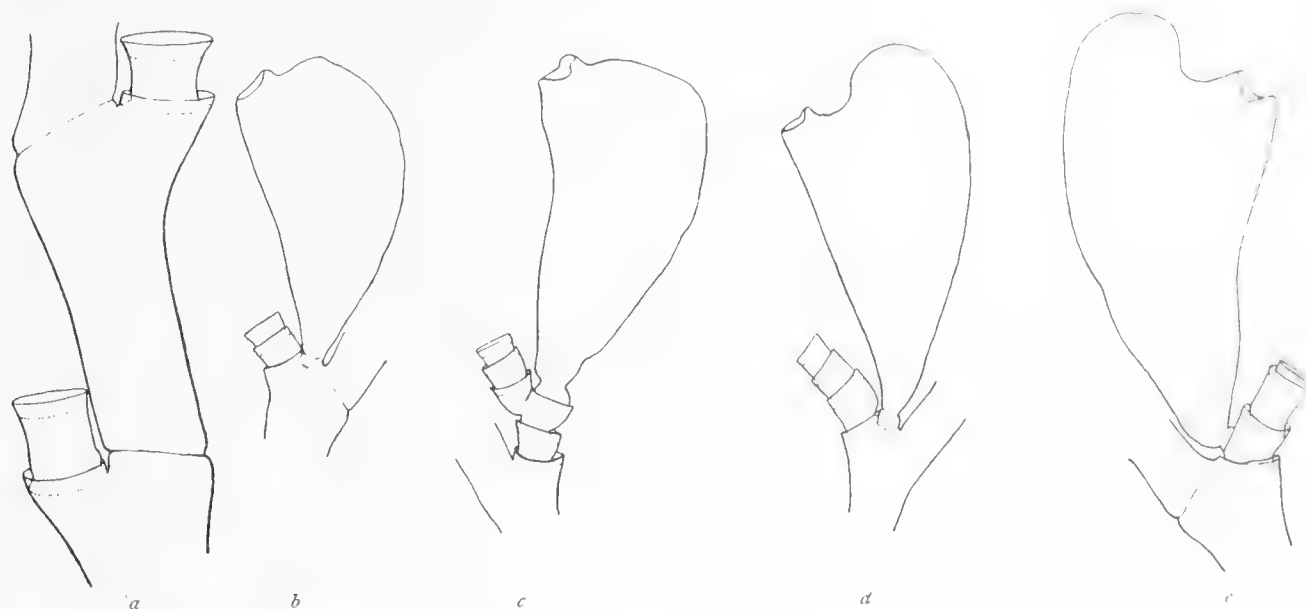


Fig. XIV a—h. *Halécium scutum*.

a. Internodium and secondary hydrotheca. Davis Strait 100 fathoms ($\times 60$).

b—c. Gonothecæ from a colony (♀) in Kara sea ($\times 30$).

f—h. Gonothecæ from a colony (♀) in Davis Strait depth 100 fathoms ($\times 30$).

Every gonotheca contains fully developed planula larvae.



The material includes several specimens of *Halécium scutum* which had previously been determined as *Halécium Beanii*; this shows, that extreme caution should be observed in dealing with records in literature of the last-named species, the occurrence of which under arctic conditions is, as above mentioned, doubtful. *Halécium scutum*, on the other hand, is an arctic character form, with circum-

polar distribution. In the waters investigated (fig. XV) it is found in the lower part of the littoral region, but quite exceptionally, as at the Faroe Islands, does it penetrate to any considerable extent into the warmer boreal waters.

Halécium curvicaule v. Lorenz.

1886 *Halécium curvicaule*, v. Lorenz, Polypomedusen von Jan Mayen, p. 25, pl. 2, figs. 1—2.

Colonies creeping or upright, with irregular, more rarely almost dichotomic ramification, monosiphonic hydrocaulus. Hydrothecæ terminal: the next hydrotheca stalk or branch internodium proceeds

from an almost spherical apophyse situate close under the terminal hydrotheca. The hydrotheca itself is low, somewhat broader at the aperture than at the faint diaphragm, more rarely with margin slightly bent over. Secondary hydrothecæ occur in smaller numbers. The hydrotheca stalks are as a rule fairly long, as a rule with a couple of rings below.

The gonothecæ proceed from the hydrotheca stalks close under the polyp, and are attached by a short, often almost quite rudimentary stalk, or are exceptionally formed as heterorenovates in the hydrothecæ. The males are elongated oval or narrowly egg-shaped, attached to the colony by their narrower end. The female gonothecæ are practically pear-shaped, laterally compressed, and with a pair of hydranths in the distal, asymmetrically placed opening; on the side opposite this aperture, the

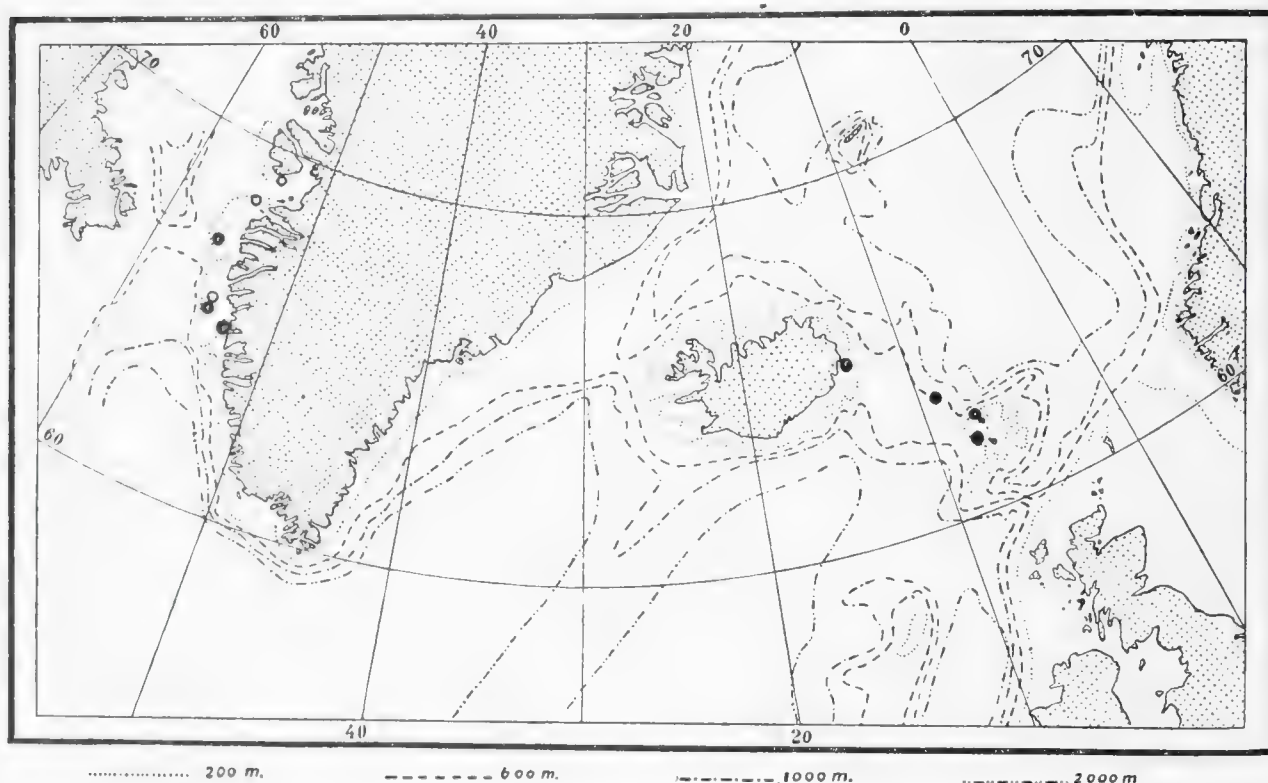


Fig. XV. Finds of *Halecium scutum* in the Northern Atlantic.

○ Localities of *Halecium Beanii* after Kramp (1914), referring to *Halecium scutum*.

gonotheca has 2–9 transverse furrows, more or less pronounced, at times almost imperceptible; they never reach right round the gonotheca.

“Ingolf” St. 29, 65°34' N., 54°31' W., depth 68 fathoms, 0.2°

Greenland: Egedesminde (without further details)

Iceland: Bakkefjord, depth 10 fathoms

Hvalfjord, — 46 metres.

A detailed description of *Halecium curvicaule* has been given by Dons (1912 p. 61) who shows, that *Halecium mirabile* Schydlowsky and *Halecium repens* Jäderholm are synonyms to this species.

Examination of a large amount of material leaves no doubt as to the correctness of this. The species is enormously multifarious in its power of variation, and has a remarkable capability of changing its appearance; an examination of the branches, however, will always reveal the characteristic, almost spherical apophyse typical of the species, and the distinguishing characters established are seen to be founded on growth stages.

Dons does not appear to have noticed that his figure D. 5 shows how the male gonotheca can be formed in hydrotheca as a heteromorphotic renovate. This is particularly interesting in the case of the present species, since other heteromorphotic renovates likewise appear in the same in nature, as tendril-like stolon formations in place of hydranths. Dons mentions such renovates, with illustra-

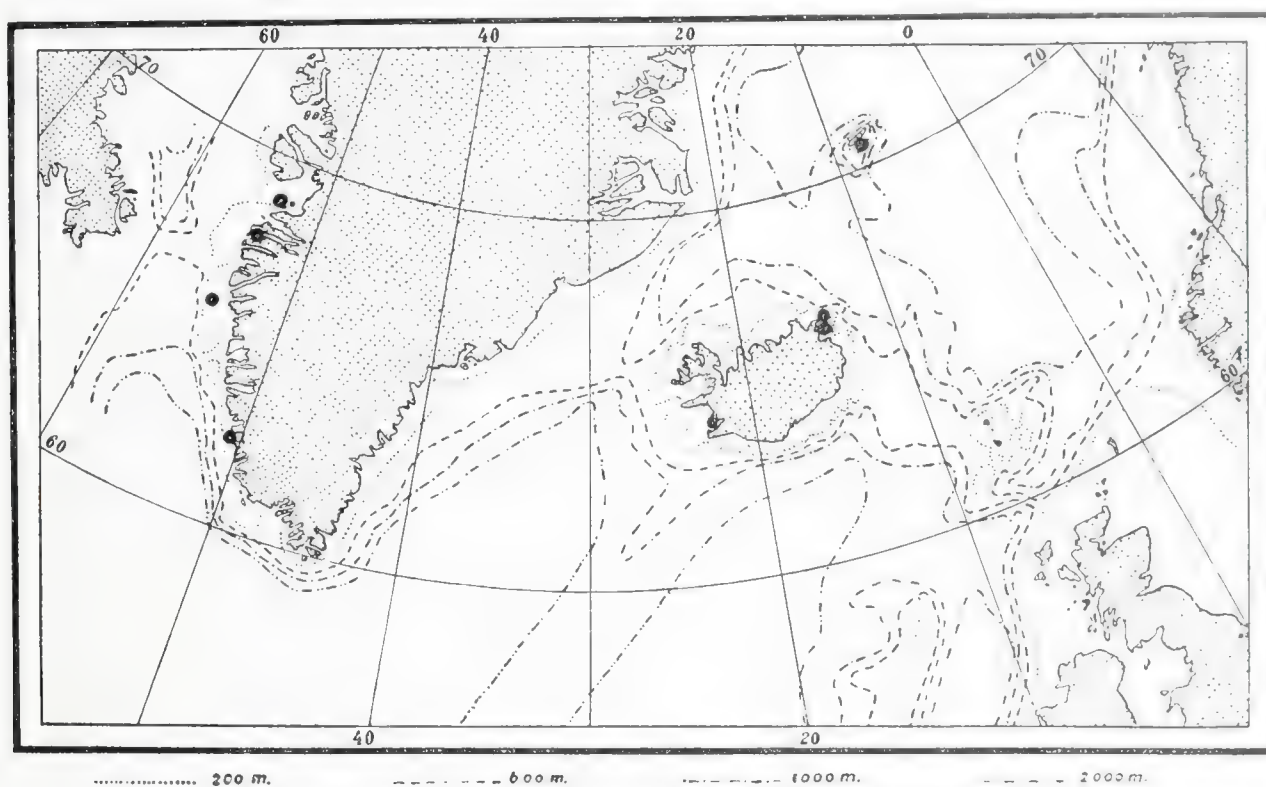


Fig. XVI. Localities of *Halecium curvicaule* in the Northern Atlantic

tions, and points out that these very features have served as the basis on which the species *Halecium mirabile* was established. The species is thus characterised by a less lively hydranth renewal, but has on the other hand a more marked tendency to form heteromorphotic renovates than most other forms of *Halecium*.

Halecium curvicaule is a markedly high-arctic species, belonging to the littoral region. Only quite exceptionally does it penetrate into boreal waters (fig. XVI) as for instance at Iceland. Off the coast of Norway it has not yet been met with south of Bjarkøy.

***Halecium muricatum* (Ellis and Solander) Johnston.**

1786 *Sertularia muricata*, Ellis and Solander, The natural history of many curious and uncommon Zoophytes, p. 59, pl. 7, figs. 3—4.

1847 *Halecium muricatum*, Johnston, A history of the British Zoophytes, p. 60, pl. 9, figs. 3—4

Upright colonies with polysiphonic, irregularly ramified main stem, and regular singly or doubly pinnate branches; the outer, minor branchlets regularly alternating. The hydrothecæ small, with expanded margin, especially on the adcauline side; the basal cavity is large, somewhat asymmetrically developed, with a markedly convex adcauline wall and a straight or slightly concave abcauline wall, inserted asymmetrically on a laterally placed apophyse at the distal end of the internodium. The branches are divided into internodia, which often exhibit one or two basal constrictions.

The gonothecæ proceed from the tubes of the stem. They are large, somewhat flattened, and furnished with spiny longitudinal ribs on the flat side.

Material:

"Ingolf" St. 29 65°34' N., 54°31' W., depth 68 fathoms 0,2°

— - 34 65°17' N., 54°17' W., — 55 —

— - 84 62°58' N., 25°24' W., — 633 — 4,8°

"Thor" 65°52' N., 23°58' W., — 62 metres

— 64°16' N., 22°17' W., — 50 —

— 64°16' N., 11°15' W., — 378 —

Greenland: Egedesminde (without further details)

Store Hellefiskebanke (— — —)

Store Hellefiskebanke depth 24 fathoms

Davis Strait (— — —) — 100 —

Ingmikertok, Angmagsalikfjord (East Greenland Expedition)

Iceland: Mouth of Hornafjord (depth not stated)

Rodefjord, depth 80 fathoms

Djupivogr — 8 —

Vestmanö — 10—15 —

10 miles W. of Akranes (depth not stated)

Stykkisholm, depth 30 fathoms

Bredebugt 65°17' N., 23°32' W., depth 7—12 fathoms

Adelvik (depth not stated).

The Faroe Islands: 7 miles N. by E. of Myggenæs point, depth 57 fathoms

6 miles N. by W. of Store Kalsö, — 60 —

Deep hole at north point of Nolsö — 100 —

5 miles SSE. of Bispen — 50 —

Forma abyssalis:

"Ingolf" St. 125, 68°08' N., 16°02' W.; depth 729 fathoms, — 0,8°

Halecium muricatum, with its asymmetrically developed hydrotheca stalks or basal cavities and its slenderer form, stands out distinctly from the remainder of the northern *Halecium* species, and is not easily confused. It is as a rule finely built, but may occur in large colonies with highly ramified polysiphonic main stem; the ramification then mostly proceeds in a main plane, but can also be altogether irregular, so that the colonies assume a quite bushy appearance. The margin of the hydro-

theca can vary with regard to curvature, and may in extreme cases somewhat resemble *Halecium labrosum*; in *Halecium muricatum* however, we always find that the adcauline margin of the hydrotheca is more markedly curved, the abcauline less so.

Normally, the length of the internodium is about three times its distal breadth (including the apophyse); we have, however, from the "Ingolf" St. 125, a colony which, from its extremely long internodia, must be regarded as a deep-sea variant (fig. XVII *b*), forma *abyssalis* nov. It is not unusual among hydroids to find that the colonies from greater depths exhibit an extension of the single branch parts; in this case, however, the tendency is pushed to an extreme, and at a first glance, the colony presents an altogether alien appearance. It is probably due to the fact that the species here occurs in the cold area, at the considerable depth of 729 fathoms. The colonies are very slender, about 10 cm high, with polysiphonic stems. The internodia of the minor branches are 3–4 mm long, about five times the distal breadth incl. apophyse. The apophyse itself is very distinctly marked and bears a slender hydrotheca. The hydrotheca has close under the diaphragm the typical adcauline thickening of the wall, the "pseudodiaphragm" which as a rule is also found in the typical form. The hydrothecæ exhibit the form typical for the species; the secondary hydrothecæ are comparatively short-stalked, but otherwise of the same shape as the primary. The colonies are sterile. From the features mentioned it follows that

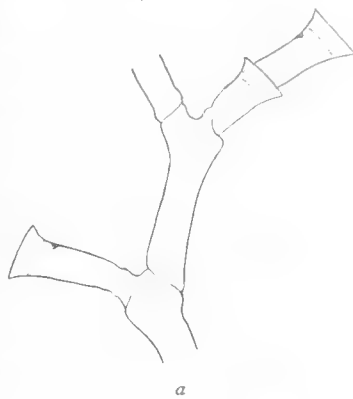
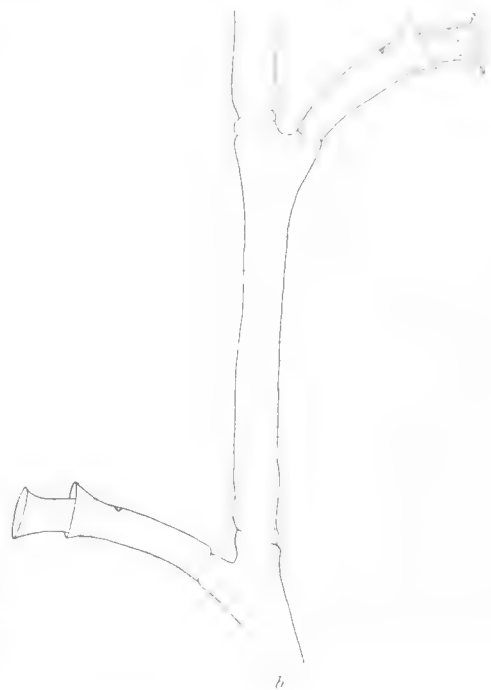


Fig. XVII *a—b*.

Halecium muricatum.

a. Internodium and hydrothecæ from a typical colony from Store Hellefiskebanke, depth 32 fath.

b. Internodium with hydrothecæ of forma *abyssalis* from "Ingolf" St. 125. (× 40).



the colonies cannot be taken as representatives of a distinct species; they should, however, be distinguished as the type of a particular forma *abyssalis* of the original species.

Halecium muricatum is a circumpolar arctic species, able to penetrate into the boreal region and out to the limits between this and warmer layers (fig. XVIII). Its principal occurrence is restricted to the upper part of the littoral region, but it may, as seen from the foregoing, penetrate far down into the abyssal. It was met with already by the Norwegian North-Atlantic Expedition at a depth of 1350 metres.

Halecium labrosum Alder.

1859 *Halecium labrosum*, Alder, Descriptions of three new species of Sertularian Zoophytes, p. 351, pl. 13.

Robust, upright, and irregularly branched colonies with polysiphonic main stem. The hydrothecæ are short, symmetrical, with markedly recurvate aperture margin. The basal cavity is very large, and bounded above by the base of the hydranth; the diaphragm rudimentary or entirely lacking. The

branches are divided into fairly short internodia, having a hydrotheca on the distal apophyse; the latter is often, though not always, separated from the basal cavity of the hydrotheca by a joint.

The gonothecæ are very large, and proceed from the tubes of the stem and branches, or from the apophyse. They are irregularly oval, flattened, without spines or ribs, the females are much larger than the males, often more flattened in proportion, but otherwise of the same shape.

Material:

"Ingolf" St. 33 67°57' N., 55°30' W., depth 35 fathoms 0,8°
 Greenland: Egedesminde (without further details)
 Store Hellefiskebanke (— — —)
 Davis Strait, depth 100 fathoms (— — —)
 — — 67°34' N., 55°20' W., (depth not stated)
 Iceland: Vadvig, depth 46 fathoms
 Vestmanö, — 28 —

Halecium labrosum is an arctic species capable of penetrating into the boreal areas (fig. XIX). In strictly arctic waters it is of very robust build, perhaps the coarsest of all arctic *Halecium* species, and can hardly be confused with others. In warmer parts, it assumes a somewhat finer structure, but should even here be reckoned among the robust forms. Bathymetrically, the species belongs to the upper part of the littoral region, and has very rarely been observed below this. The few records of its occurrence in the Mediterranean and Atlantic south of the boreal region demand renewed investigation, as much would seem to suggest that confusion has taken place.

***Halecium tenellum* Hincks.**

1861 *Halecium tenellum*, Hincks, A catalogue of the Zoophytes of South Devon, p. 252, pl. 6, figs. 1—4.
 ? 1911 *Halecium textum*, Kramp, Report on the Hydroids the Danmark Expedition, p. 368, pl. XXI, figs. 5—6.

Colonies upright, with monosiphonic hydrocaulus, and typical, somewhat irregularly sympodial growth. The branches — the new hydrotheca stalks — proceed from close beneath the basis of the terminal primary hydrotheca, not infrequently in pairs, so that dichotomic ramification takes place; more rarely several branches from the same point. Pseudohydrocauli are of minor importance in the colonies, the renewal of hydrothecæ is not particularly active. The hydrothecæ are of medium size, broadening upward from the slight diaphragm and terminating in an often recurvate opening margin. The stalk of the secondary hydrothecæ is ringed, the branches are often ringed throughout their entire length, and exhibit at any rate distinct rings above their origin.

The gonothecæ proceed from the base of the primary hydrothecæ, or more rarely, they may be formed as heteromorphotic renovates in the hydrothecæ themselves. The gonotheca is somewhat flattened; viewed from the broad side they are elongated oval, with the distal part cut off transversely or broadly rounded; seen laterally, they are more egg-shaped, with a pointed distal part. They lack hydranth pairs.

Material:

"Ingolf" St. 87 65°02,3' N., 23°56,2' W., depth 110 fathoms

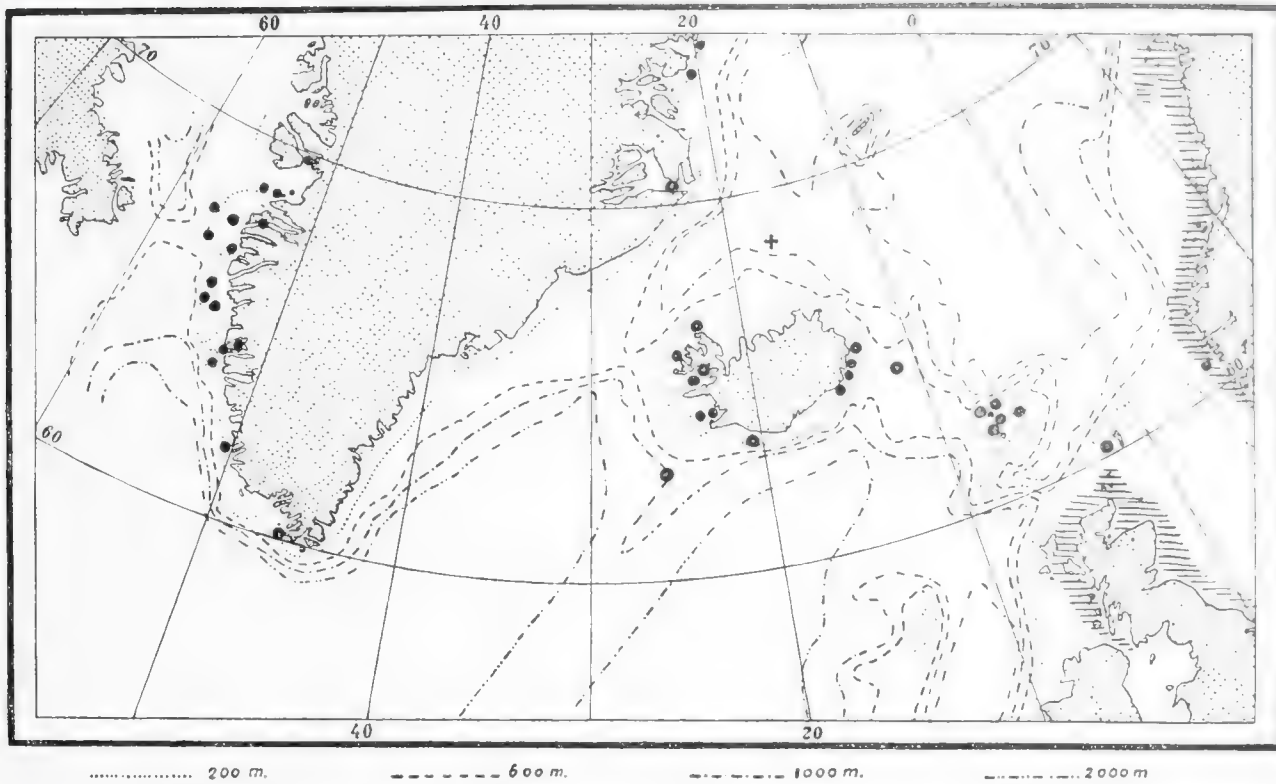


Fig. XVIII. The distribution of *Halecium muricatum* (forma *abyssalis* +) in the Northern Atlantic.
In the hatched regions the literature notes a common, although scattered occurrence.

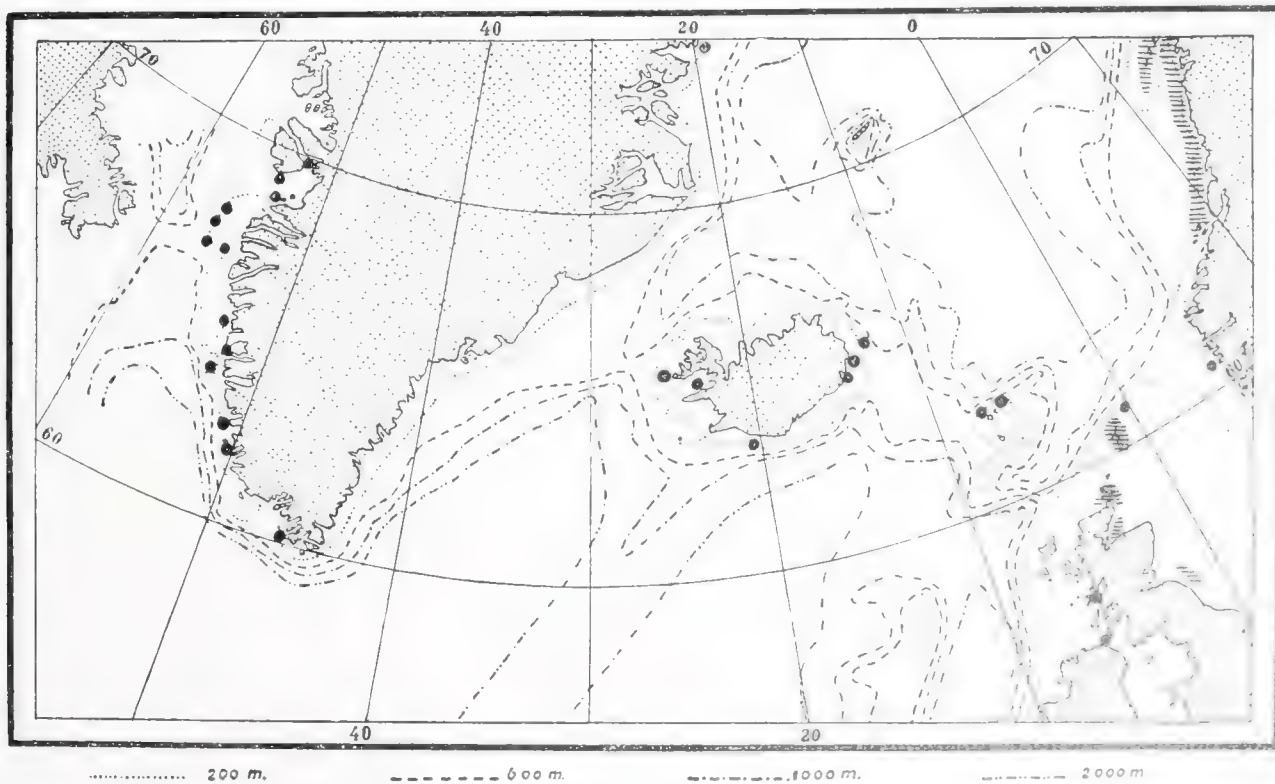


Fig. XIX. The occurrence of *Halecium labrosum* in the Northern Atlantic.
In the hatched parts the occurrence according to literature is scattered, no accurate details as to localities are given.

Greenland: Sukkertoppen, on *Boltenia* (without further details).

Iceland: Brunnes, depth. 4 fathoms

Seydisfjord — 6 —

Hvalfjord — 46 metres

Stykkisholm — 30 fathoms.

The Faroe Islands: 6 miles N. by W. of Store Kalsö, depth 60 fathoms

Deep hole at north point of Nolsö — 100 —

Glyversnæs near Thorshavn, on red algæ.



Fig. XX. *Halccium tenellum*.

♀ from "Ingolf" St. 87.

By * a gonotheca formed as heterorenovate.
(× 20).

There may be some possibility that the colony here shown (fig. XX) from the "Ingolf" St. 87 does not altogether agree with *Halccium tenellum*. On comparing with the descriptions given by Hincks (1868 p. 226, pl. 45, fig. 1c.), Ritchie (1907 p. 525), and Jäderholm (1909 p. 14) the gonothecæ do not agree with those shown. Hincks describes them as follows: "the capsules vary in form, being broadly ovate, or slender and somewhat pointed above; they contain a single, large gonophore". His figure shows us a slenderly oval or more pear-shaped gonotheca broadly rounded at the distal end. Ritchie's description is as follows: "The gonangia are ovate, broad in the proximal region, obtusely pointed in the distal. They are supported on short stalks, which arise from the sides of the hydrotheca, and always from the lowest segment in any hydrotheca tier". Jäderholm writes: "Gonotheken eirund, unter den Hydrotheken ausgehend und (nach Thornely) auch von der Hydrorhiza und aus der Hydrothekenmündung. Distale Zähne fehlen". From the statements here quoted, it is not easy to gain a clear impression of the

gonangia, and none of them will altogether cover the present fertile colonies, of which there are not a few in my material, and which agree with the specimen shown.

The gonothecæ are here set on short stalks, close under the primary hydrothecæ, or may exceptionally arise from the interior of the same; this agrees with the statements given above, as also with a later observation by Ritchie (1911 p. 30) where however, nothing new is stated as to their shape. The gonotheca contains, as Hincks points out, a single large gonophore, but the state of preservation of the material did not permit further investigation of this. On the other hand, the shape of the gonotheca agrees but ill with Hincks's drawing, and forms rather a cross between the description given by Ritchie and that of Jäderholm, not improbably because the gonothecæ are somewhat flattened. In lateral view, they are egg-shaped, with a broad basal part, and pointed distal end; viewed from the flat, on the other hand, they are more elongated oval, more or less transversely cut off at the distal end. On comparing this with the passage from Hincks's description quoted above, we find that his expression "broadly ovate, or somewhat pointed above" agrees after

all, as long as we bear in mind that the two statements refer to the gonotheca as viewed in the one case from the flat, in the other from the side. Consequently, all things considered, I regard the colonies in question as representatives of *Halecium tenellum*.

Jäderholm (1909 p. 55) notes *Halecium Schneideri* (Bonnie) (1898 p. 10) as synonymous with *Halecium tenellum*; this, however, requires further justification. The shape of the colony, and the lively formation of pseudohydrocauli in *Halecium Schneideri*, agree rather with *Halecium minutum*, but the identity of the species is altogether doubtful, from the data we possess. Should the female gonothecæ prove to correspond with Schneider's *Halecium nanum* (1898 p. 481) then we have here a species entirely distinct from *Halecium tenellum* and *Halecium minutum*. Similarly, it may be doubtful

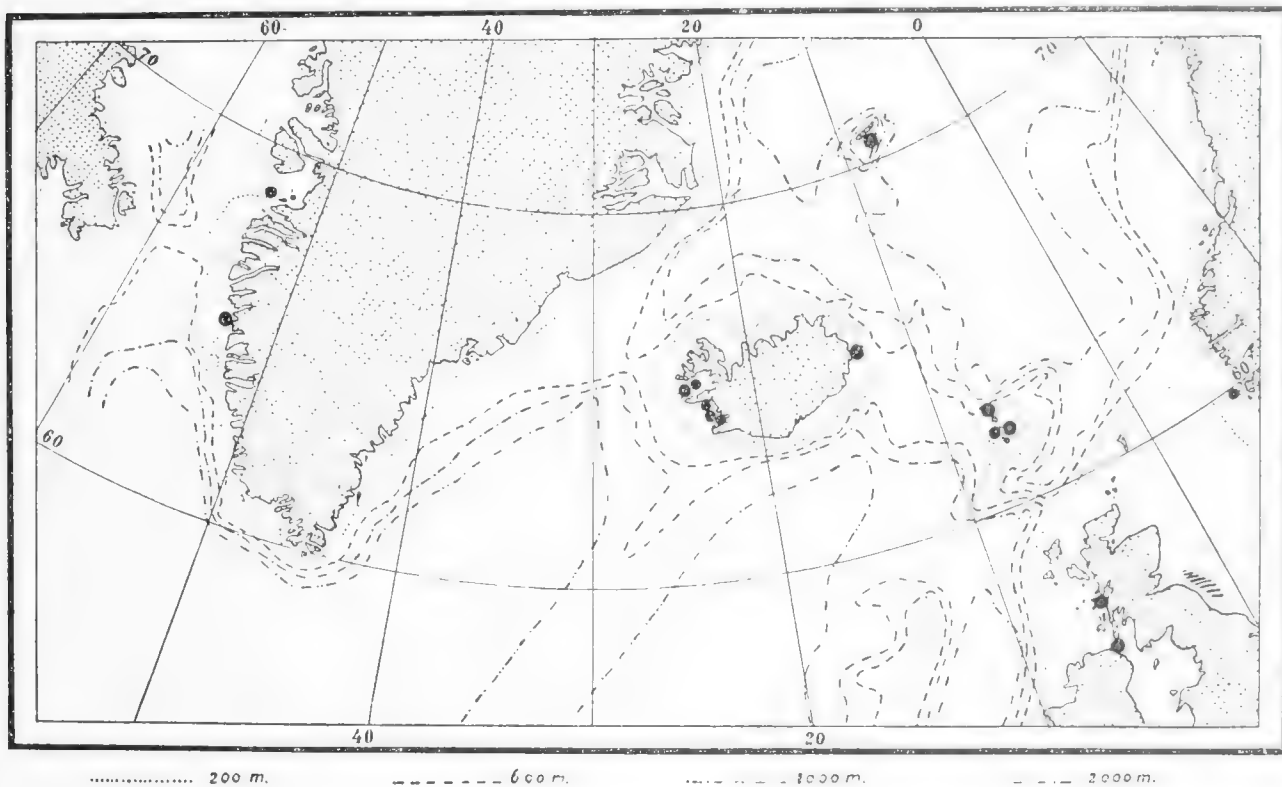


Fig. XXI. Finds of *Halecium tenellum* in the Northern Atlantic.

whether the species noted by me (1913 p. 17) as *Halecium tenellum*, from the Adriatic, really belongs here; the method of growth of the colony, and its dimensions, differ to such a degree from what is found in northern specimens of *Halecium tenellum*, that we must await demonstration of the gonothecæ in the Adriatic form before we can determine with certainty whether it belongs to this species.

The colonies agree on the other hand very well with the *Halecium textum* described by Kramp (1911 p. 368); the marked curvature of the hydrotheca margin in this species is not more pronounced than is frequently met with in *Halecium tenellum*; here, however, we must also await the finding of gonangia. It would also seem likely, as Kramp (1914 p. 1003) points out, that the *Halecium crinis* described by Stechow (1913 p. 79) belongs under *Halecium tenellum*; Stechow's interpretation of the manner of ramification in the colony is based upon an entirely erroneous appreciation

of the actual conditions; a point which has likewise been demonstrated by Kramp. Stechow's drawings in the mentioned work are sadly schematic, and thus afford but poor support.

Halecium tenellum belongs to the littoral region, and appears to occur but rarely deeper down in northern waters. From records in the literature, the species is altogether cosmopolitan, penetrating far into the Arctic waters, albeit it must here evidently have been frequently confused with the related *Halecium minutum*. Despite the fact that it is cosmopolitan, its occurrence in the boreal waters (fig. XXI) is remarkably scattered, and apparently irregular. It is probably considerably more common than appears from the chart, but occurs often in insignificant little colonies which may easily escape notice.

Halecium minutum Broch.

1903 *Halecium minutum*, Broch, Die von ... "Michael Sars" ... gesammelten Hydroiden, p. 4, Taf. I, figs. 1-4.

Colonies upright, generally with small, monosiphonic hydrocaulus, with regular, zigzag shaped sympodial growth; these small colonies arise as a rule from creeping stolons, but at times the stolons may collect together into well developed, branched and polysiphonic rhizocaulome-like formations, from which small branches with sympodial ramification proceed. New branchlets arise from under the base of the primary hydrothecæ, normally only one branch at the hydrotheca. The renewal of the hydrothecæ is lively, and gives rise to pseudohydrocauli, which may more rarely serve as the base for secondary sympodial formations. The hydrothecæ are fairly large, expanding considerably upwards from the slightly developed diaphragm, and have as a rule a highly curved margin; the stalks of the secondary hydrothecæ are ringed; the branches have distinct rings under the uppermost hydrothecæ, rarely elsewhere.

The gonothecæ arise from the creeping stolons or from the tubes of the polysiphonic parts of the colony. The females are very large, up to 3 mm. long, broad oval to round, and may not infrequently even be broader than long; they are highly flattened, with spines along the edge, especially in the distal part. The male gonothecæ are smaller, elliptical, and smooth; they may also proceed from beneath the base of the primary hydrothecæ.

Material:

"Thor" 66°19' N. 23°14' W.; depth 115-120 metres

Greenland: Egedesminde (without further details)

Iceland: 9 miles N.74°E. of Hornet, depth 38 fathoms

Vadlavik,	—	80	—	[labelled <i>Halecium tenellum</i>]
Djupivogr	—	8	—	[— — —]
64°17' N., 14°44' W.	—	75 metres	[— — —]	
Skagi	—	40	—	
Hvalfjord	—	46	—	[— — <i>Schneideri</i>]
Skjalfandi Bay	—	28 fathoms.		

Kramp's studies (1913 p. 5) of *Halecium minutum* are highly interesting. He has succeeded in finding fertile female colonies, the identity of which is thus placed beyond doubt, but where the

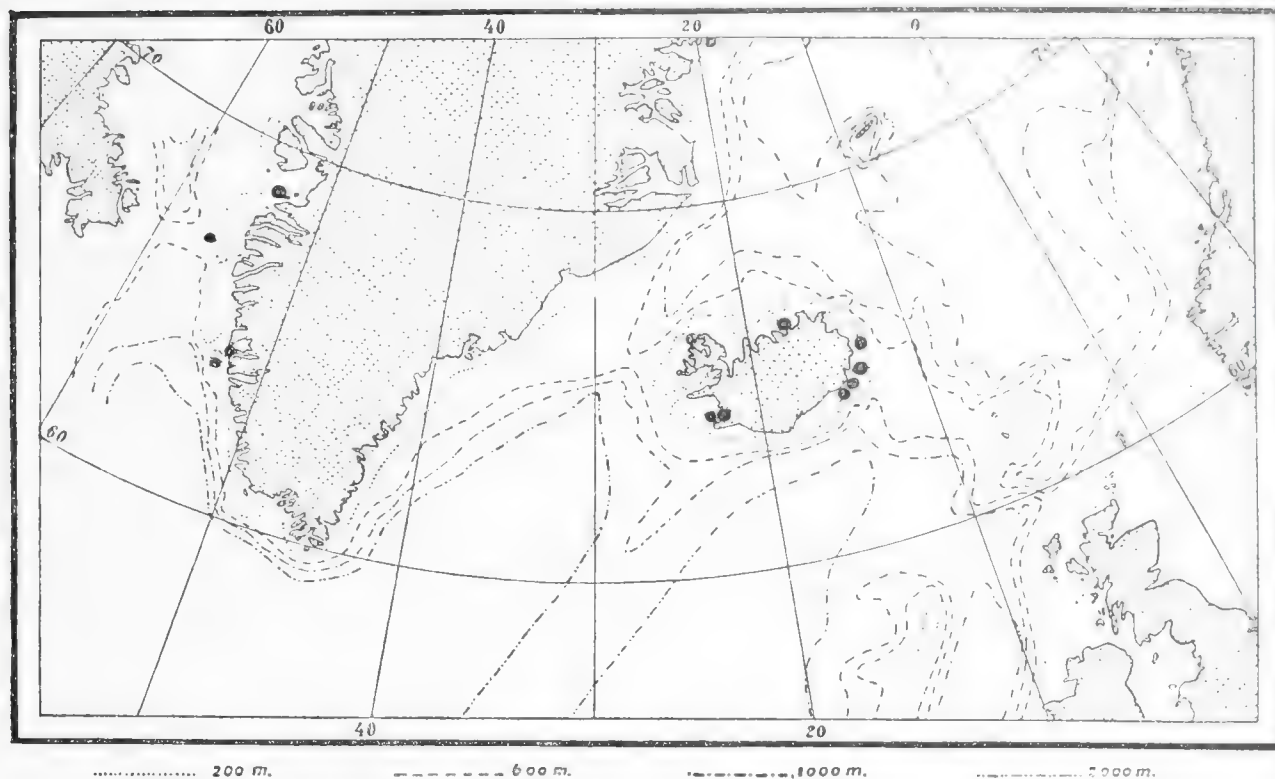


Fig. XXII. Finds of *Halecium minutum* in the Northern Atlantic.

small sympodial parts, normal in appearance, arise from enormous rhizocaulome formations instead of from creeping stolons. This, as Kramp also points out, places the question of growth conditions as generic character in a remarkable light; and what is worse, it shows us that the shape of the colony can even in specific limitation only be applied with great discretion, a point which has also been noted here under the heading of *Lafoëidae*. Kramp thus supports my supposition (1909 p. 153) that the colonies which Jäderholm (1907) mentions from the Bering Sea under the name of *Halecium telescopium* should more probably be ascribed to *Halecium minutum*.

Halecium minutum is an arctic species which has doubtless a considerable distribution in the Polar Sea, but which is often confused with others, and especially with *Halecium tenellum*, as is also clearly evident from the list of investigation material given above. Apart from the Bering Sea, the species has been recorded at Spitzbergen, the Murman coast, east and north coasts of Iceland, northern east coast of Greenland, and several places along the west coast; finally also Fraser (1913 p. 168) has met with it at Nova Scotia, on the Canso Bank. The species penetrates but very slightly into the boreal region, as far as can be seen from the finds made up to now.

Family Plumulariidae.

The hydrothecæ are small, sessile, approximately radially symmetrical, one side partly or entirely fused with the branches (tubes); the diaphragm is somewhat asymmetrical. The large polyps can practically speaking never be drawn entirely into the hydrothecæ. The sarcothecæ are two-chambered,

stalked and mobile, or small, rudimentary or entirely effaced, being represented merely by holes in the periderm, at times with slightly raised, asymmetrical edges. The margin of the hydrotheca is almost always without teeth. The colonies are monopodial with terminal growth point. The gastral endoderm of the polyp is divided into a fore stomach and a digestive stomach part, the limit between them appearing as a constriction round the body of the polyp.

As thus defined, the family covers the group *Eleutheroplea* auctt. but it also further includes such primitive forms as *Kirchenpaueria*, which lacks true sarcothecæ. What have been taken for such are in reality merely low, as a rule somewhat asymmetrically developed margins round the aperture in the periderm through which the sarcostyle passes out. This formation cannot be altogether regarded as a parallel to the sarcotheca, which forms the fixed point of support for the sarcostyle, and is as a rule furnished with a diaphragm in *Plumulariidae*.

On the other hand, it must be admitted that there are certain transition forms which render the limit between *Plumulariidae* and *Aglaopheniidae* somewhat indistinct at times, as we find species with both stalked mobile, and immobile, sessile sarcothecæ; these forms must be regarded as primitive *Aglaopheniidae*. Such transition forms are also met with as against *Haleciidae*, though it has not in this case been found advisable to unite the two families. We find, as a matter of fact, in almost every hydroid family such intermediate forms, the position of which is more or less a matter of doubt. If entirely definite boundary lines had to be drawn, it would very possibly involve the reduction of the entire group of hydroids to one or two families. But the heterogeneity would then be too great. In the same way, the *Plumulariidae*, as viewed by Nutting (1900) and Stechow (1913) make a too heterogeneous group, which as both writers also admit, really comprises two very well defined main groups. As these two main groups differ in principle, as much as any two families in the other family series of thecaphore hydroids, and as, moreover, the intermediate forms here are neither more numerous nor more marked than elsewhere, it will be correct to keep the two groups apart as separate families.

Gen. *Kirchenpaueria* (Jickeli).

Upright pinnate colonies, the stem bearing on its apophyses only undivided branches (hydrocladia) with several hydrothecæ, these being unilaterally arranged, and fused with the branch. Beside the nutritive polyps appear the sarcostyles, which proceed from holes in the periderm; these holes are often surrounded by a slightly raised, as a rule somewhat asymmetrically developed periderm collar. Paired sarcostyles lacking.

Bedot (1916) reintroduces this genus, and defines it further in such a manner that the old *Sertularia pinnata* Linné appears as its typical species.

In the list published in 1915, "Nomina conservanda. Unter Mitwirkung zahlreicher Spezialisten herausgegeben von Prof. C. Apstein" (Sitzungsberichte der Gesellschaft naturforschender Freunde, Berlin, Mai 1915) we find under polyps (p. 126—127) as type for *Plumularia* the *Plumularia pinnata* L. This is well calculated to show that a list such as the one mentioned may easily manage to defeat its own ends. Within the very large number of species which are referred to the genus *Plumularia*, the *Plumularia pinnata* takes up a quite exceptional position, owing to its reduced sarcothecæ,

which are partly or entirely lacking. If we were to follow the list, we should then be obliged, as Professor M. Bedot writes me in a letter on this matter, to alter the generic name for all the over 200 species which have hitherto been noted under genus *Plumularia*. There is, as Professor Bedot further writes, nothing to suggest that Lamarck, the founder of the genus, ever regarded *Plumularia pinnata* as the type species in preference to any other then known species of the genus. There would seem much more reason to establish *Plumularia setacea* as type species. That a generic distinction should be made between *Plumularia pinnata* and the remaining species, where the sarcothecæ are far more highly developed, and generally appear partly paired, is beyond all doubt; this Stechow (1913 p. 25) also points out, and suggests *Kirchenpaueria* as generic name for the group, but without going further into the matter.

There are indeed several objections to be made to the mentioned list as regards the hydroids. That the authors note the genera *Clytia*, *Gonothyraca*, *Pasythea*, *Podocoryne*, and *Schizotricha*, may be taken for a party contribution to the dispute as to leading fundamental principles in systematics, which has no place in such a list, given without justification or explanation; the effect here is merely to create confusion, not to form a basis for firm and tenable conditions. Here again there is no question of names rendered so familiar through the medium of the handbooks as to have any claim to acknowledgement on that count. Furthermore, the revival of a name such as *Monocaulus* is more confusing than the retention of the later, generally employed appellation *Branchiocerianthus*. The authors have here evidently failed to realise that the type species given, *imperator*, does not as a matter of fact occur at all in Allman's original *Monocaulus* genus, which was founded on northern *Corymorpha* species with sessile gonophores, while the mentioned species was not found until later, by the "Challenger", and incorrectly placed in the genus *Monocaulus*, with the original diagnosis of which the species does not agree at all. We may further note the question as to whether *Antennularia* or *Nemertesia* should be retained. The latter name is generally adopted in later works by Stechow, Broch and Billard, and is likewise recognised in Bedot's eminent historical nomenclature studies, and neither of the names can be said to be of over frequent occurrence in the handbooks; the retention of *Antennularia* is here less due to sound defensible reasons than it is a matter of taste. — But we cannot here go farther into details with regard to this list; the foregoing will be sufficient to show that in its present form it is far from attaining the end proposed by discussion as to the retention of names whose alteration would bring about confusion in zoological handbooks and teaching works.

As regards the generic name *Kirchenpaueria*, there may be some little hesitation. The name in question first appears as a synonym in Kirchenpauer's paper *Neue Bryozoen, Catalog IV des Museum Godeffroy, Hamburg 1869*, where we find *Kirchenpaueria elegans* Greeff in litt. = *Reichornia Greeffii* Kirchenpauer. In the Bryozoa literature it occurs again only in E. C. Jelly, *Synonymic catalogue of the recent Bryozoa, London 1889*, as *Kirchenpaueria elegans* Graeffe, Kirch. in litt. — Jickeli introduces the name in 1883 for a hydroid which, as Bedot points out (1916 p. 641) is identical with *Plumularia pinnata*. Strictly speaking then, we should according to the precise rules of nomenclature perhaps rather have taken another name, but I regard it nevertheless as most correct for the present to follow Bedot, as there can hardly be any risk of confusion thereby. The generic name *Kirchenpaueria* is therefore here maintained for the genus whose type is *Sertularia pinnata* Linné.

***Kirchenpaueria pinnata* (Linné) Bedot.**

1758 *Sertularia pinnata*, Linné, *Systema naturæ*, ed. 10, p. 813.

1916 *Kirchenpaueria pinnata*, Bedot, *Sur le genre Kirchenpaueria*, p. 645.

Upright, singly pinnate colonies with monosiphonic or more rarely, in the basal part polysiphonic stem. Hydrocaulus divided into internodia with one or several apophyses alternating to either

side. The apophyses have each an unbranched hydrocladium, divided by transverse joints into segments with numerous hydrothecæ. Each, or more rarely, every alternate internodium on the hydrocladium has on its distal half a hydrotheca entirely fused down its one side with the internodium, or more rarely having a low free adcauline edge. The hydrotheca-bearing internodia are also distally furnished with a median pore, proximally with a median pore having raised edges, through which the naked sarcostyles pass. The length of the hydrotheca varies between $\frac{1}{2}$ and $\frac{1}{8}$ of that of the internodium.

The gonothecæ are situated on the stem or on the basal parts of the hydrocladia, without

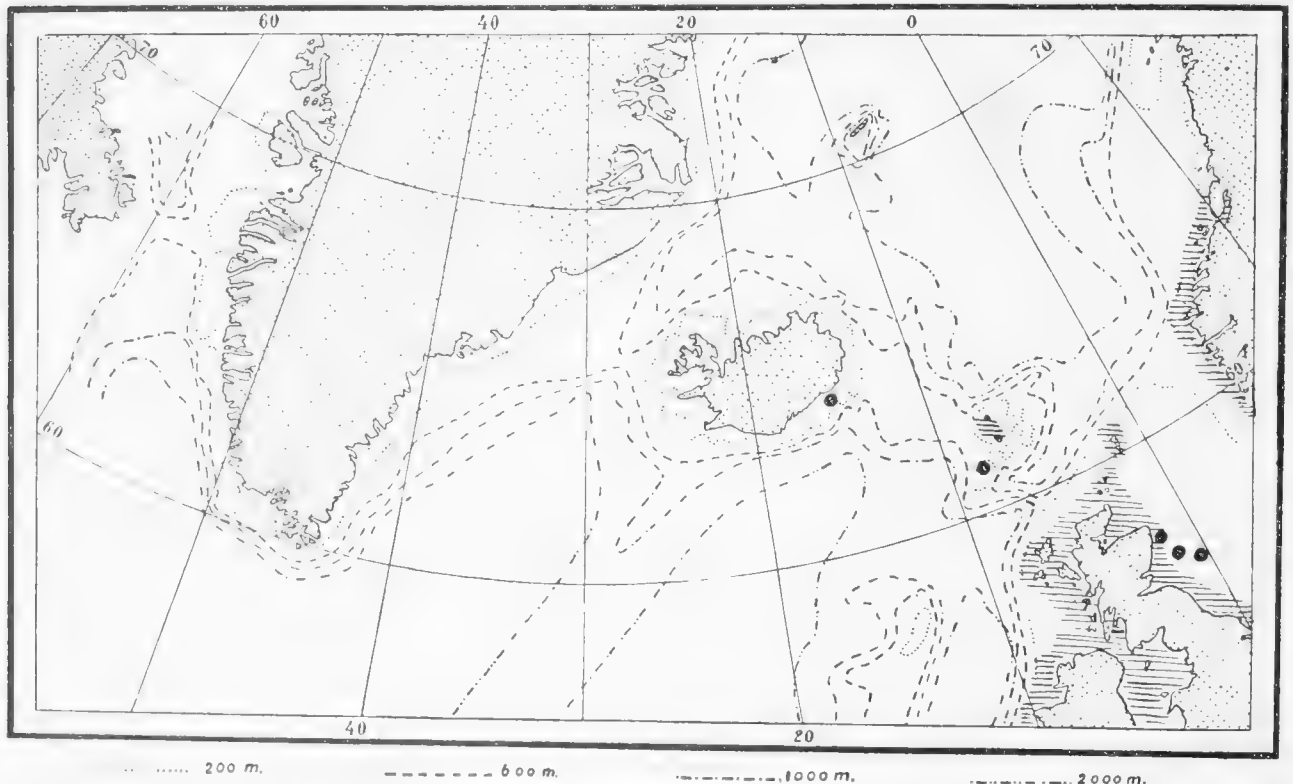


Fig. XXIII. The distribution of *Kirchenpaueria pinnata* in the Northern Atlantic.

In the hatched regions a common occurrence is stated by the literature.

special protective organs. They are oval to pear-shaped, smooth or spiny, often much flattened from the side.

Forma *typica*. Short internodia with hydrothecæ in length from $\frac{1}{3}$ to $\frac{1}{2}$ the internodium.

Forma *elegantula* (G. O. Sars) slender internodia with small hydrothecæ, length as a rule from $\frac{1}{5}$ to $\frac{1}{8}$ of the internodium.

Material (forma *typica*):

Greenland? (without further details).

The Faroe Islands: (without further details) [= *Plumularia echinulata* Winther].

The synonymy of the species has recently been worked out by Bedot (1916). It gives us an interesting insight into the variability of a species, and throws a sharp light upon several of the

distinguishing features which have hitherto been regarded as good specific characters in *Plumulariidae*. There are undoubtedly, among the numerous recorded species of *Plumularia*, synonyms in abundance, and the new species and varieties which are constantly being described do not make matters better. New forms demand not only morphological but also other justification, as is the case with the forms here noted. The variant group indicated as forma *typica* penetrates exceptionally (*Plumularia Helleri*) right into the Mediterranean, but has otherwise its main distribution in the boreal waters and in sub-antarctic regions, thus exhibiting a tendency to bipolar occurrence (cf. Broch 1914). Forma *elegantula* on the other hand, which is remarkable for its fine slender build, predominates under tropical-subtropical conditions, and is only on rare occasions met with in the temperate seas.

The area of distribution for *Kirchenpaueria pinnata* forma *typica* in northern waters coincides in the main with the fields on the chart (fig. XXIII); it is likely, however, that new finds will be made off the coast of Iceland, and we must wait until the species has been further localised in Greenland waters, before the query on the label can be erased. *Kirchenpaueria pinnata* appears in the northern waters as less susceptible to diminished salinity, and thus penetrates far up into the fjords; lower temperature, however, soon sets a limit to its progress. In the northern seas, it belongs to the littoral region, especially the upper half of the same, and only exceptionally occurs down in the abyssal.

Gen. *Plumularia* (Lamarck).

Upright, single or double pinnate colonies, the stem bearing on its apophyses undivided branches (hydrocladia) with hydrothecæ unilaterally arranged, and partly or entirely fused with the branch. The apophyse lacks sessile large sarcothecæ; the sarcostyles are situated in two-chambered mobile sarcothecæ, generally a pair at the mouth of each hydrotheca.

Plumularia setacea (Linné) Lamarck.

1758 *Sertularia setacea*, Linné, Systema naturæ, ed. 10, p. 813.

1816 *Plumularia setacea*, Lamarck, Histoire naturelle, vol. 2, p. 129.

Single pinnate colonies with monosiphonic main stem. The stem is divided into short internodia, each with a distal apophyse, turned alternately to either side. Each apophyse has a hydrocladium divided by transverse joints into internodia, of which latter every alternate one bears a hydrotheca and three sarcothecæ, and every other one or exceptionally two sarcothecæ in the median line; the hydrotheca-bearing internodium has a proximal, median sarcotheca, and a supracalycine pair at the opening of the hydrotheca. The length of the hydrotheca varies between $\frac{1}{2}$ and $\frac{1}{5}$ the length of the internodium. The hydrotheca is fused throughout its whole length with the hydrocladium.

The gonothecæ arise from the branch apophyse on the stem. They are elongated oval, with a cylindrical, narrow, often somewhat curved neck; the males are smaller than the females. The colonies are as a rule hermaphroditic, with the male gonangia on the basal part.

Forma *typica*: length of hydrotheca $\frac{1}{2}$ — $\frac{1}{3}$ the length of the internodium; the internodia comparatively coarsely built.

Forma *microtheca*: length of hydrotheca $\frac{1}{4}$ — $\frac{1}{5}$ the length of the internodium; the internodia of slender build.

Material (forma *typica*):

"Thor" 35°57' N., 5°35' W., depth 740 metres

Iceland: Vestmanö, depth 50 fathoms.

Plumularia setacea divides in the same manner as the foregoing into a widely distributed warm water variety, forma *microtheca*, and a temperate forma *typica*, occurring both in subantarctic and boreal waters. *Plumularia setacea* is in northern waters a denizen of the middle and upper parts of the lit-

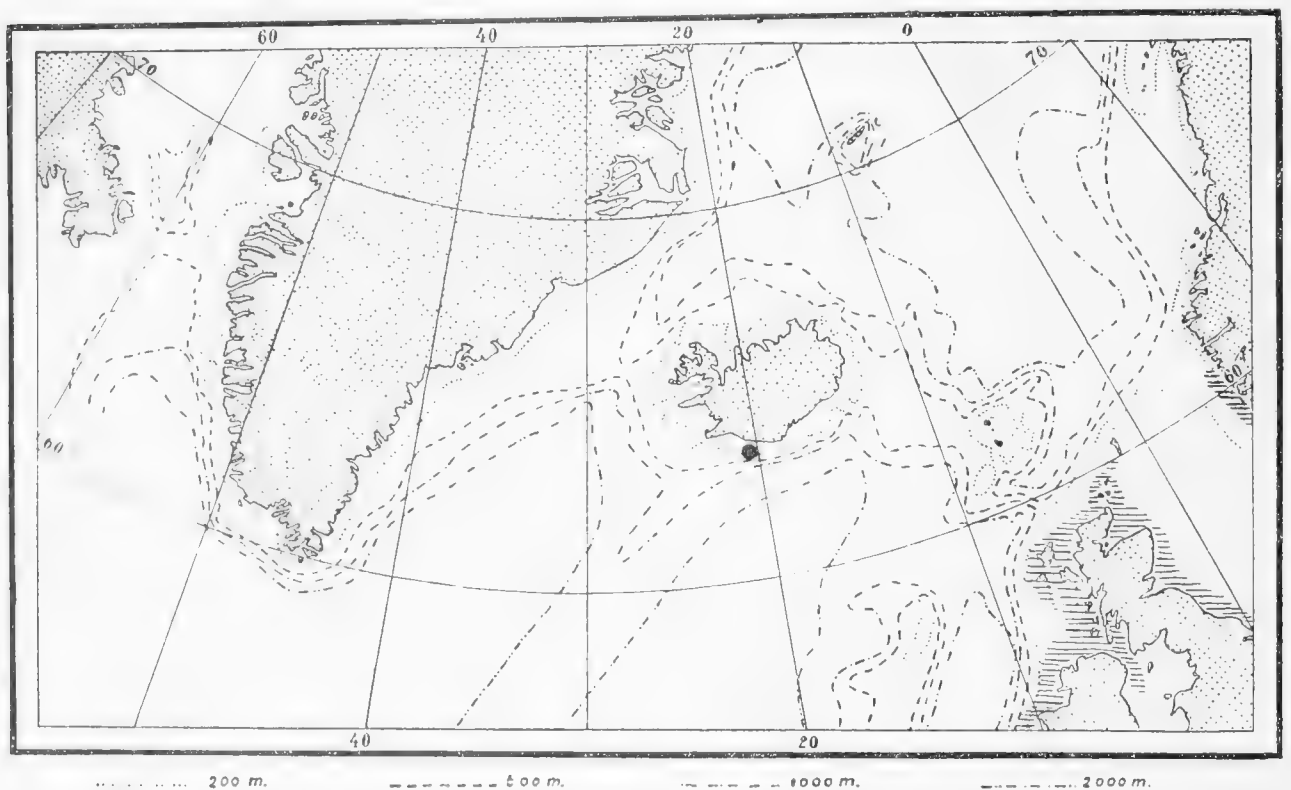


Fig. XXIV. The occurrence of *Plumularia setacea* in the Northern Atlantic.

In the hatched parts the occurrence according to the literature is common, although scattered.

toral region, whereas in warmer seas it goes fairly deep down into the abyssal region. The species is altogether somewhat rare in the boreal area (fig. XXIV) and penetrates in considerable numbers only into the southern and warmest parts of the same.

Plumularia Catharina Johnston.

1833 *Plumularia Catharina*, Johnston, Illustrations in British Zoology, p. 497, figs. 61—62.

Upright, pinnate colonies with simple or branched, monosiphonic, little pronounced stem. The branches proceed from the base of the hydrothecæ on the stem, and are as a rule placed oppositely, more rarely alternating. Stem and hydrocladia are divided into internodia by alternating transverse

and oblique nodes; above a transverse joint there is an internodium bearing one or two unpaired sarcothecæ in the median line, then the highly oblique joint, and an internodium furnished with a proximal, unpaired median sarcotheca, a large hydrotheca, and two supracalycine pairs of sarcothecæ. Of the supracalycine pairs of nematothecæ, the outermost is placed on small projecting apophyses, the inner pair arises from the internodium on the inner side of these sarcotheca apophyses. All the sarcothecæ are mobile. The hydrotheca is very slightly fused with the internodium, the adcladial side has a free portion, in length equal to the hydrotheca opening or a little less, between $\frac{1}{2}$ and $\frac{3}{4}$ the length of the hydrotheca. The hydrotheca is somewhat expanded towards the opening, and is able to accomodate the contracted polyp almost entirely.

The gonothecæ arise from the stem or the hydrocladia close beneath the hydrothecæ. The gonotheca is oval to pear-shaped, as a rule somewhat curved, the males a little more slender than the females. The female gonothecæ have basally two sarcothecæ, which, (according to Hincks) are lacking in the males.

Material:

The Faroe Islands: 6 miles N. by W. of Store Kalsö
depth 60 fathoms

Deep hole at the north point of Nolsö, — 100 —

Borönæs 13 miles in N. 75 W. — 30 —

The inner pair of supracalycine sarcothecæ in *Plumularia Catharina* (fig. XXV) appears to have escaped the attention of most investigators; it is probably this pair of sarcothecæ which has given rise to the distal median sarcotheca so often

ascribed to the species. Such median (unpaired) distal sarcothecæ I have been unable to find in the colonies at my disposal; not infrequently, however, one or both of the sypracalycine may have fallen away, rendering it difficult even to trace where they had been. It is remarkable that it should be the inner pair which exhibits such a marked tendency to fall off, exceeding that of the other sarcothecæ; the ones in question are, however, also the smallest. In view of the abundance of the present material, and the fact that I found occasion also to investigate material from other parts of the Atlantic, we must regard the statements as to occurrence of an unpaired distal sarcotheca on the hydrotheca-bearing internodium in *Plumularia Catharina* as based on incorrect interpretation of the inner pair of supracalycine sarcothecæ. There can be no doubt that the species *Plumularia geminata* Allman, *Plumularia alternata* Nutting and *Plumularia Clarkei* Nutting should be included under *Plumularia Catharina*, as I have already pointed out in a previous work (1912 p. 4); it is impossible to attach any weight to the characters given for specific distinction when once a larger material has been closely investigated.

Plumularia Catharina is a southern visitor to the boreal waters (fig. XXVI); round the British Isles it still seems to be of fairly frequent occurrence, but off the coast of Norway it is but little met with, and has only once been recorded from the south coast of Iceland. At the Faroe Islands, the

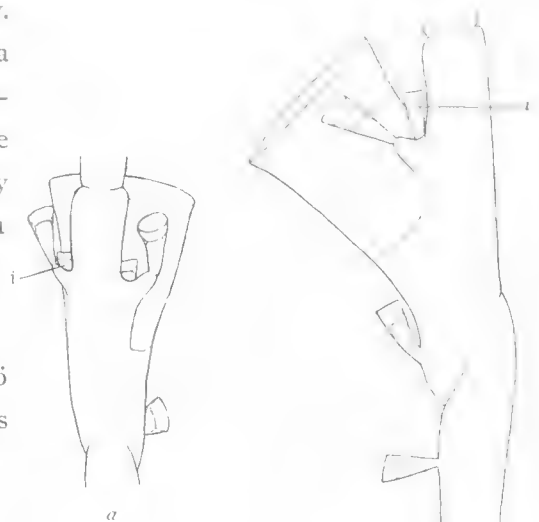


Fig. XXV. *Plumularia Catharina* from 6 miles N. by W. of Store Kalsö. a. hydrothecate internode seen from behind. — b. two successive internodes in side view. — i. inner pair of supracalycine sarcothecæ. (X 50).

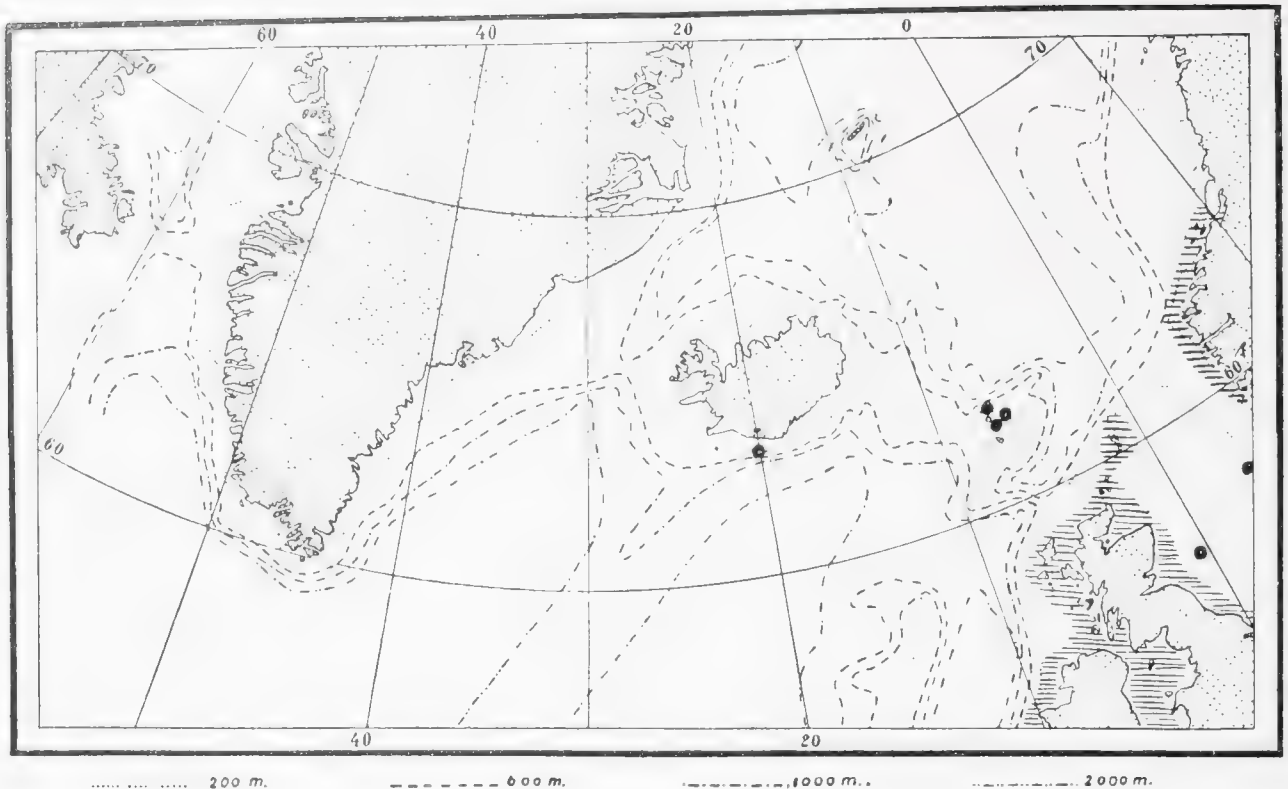


Fig. XXVI. The distribution of *Plumularia Catharina* in the Northern Atlantic.
In the hatched parts the literature notes a common, although scattered occurrence.

species seems to be somewhat more common than would appear from earlier records; at the two localities noted here, it was present in great numbers. In Greenland waters, *Plumularia Catharina* has not yet been found. It belongs especially to the upper half of the littoral region.

Gen. *Polyplumaria*¹ G. O. Sars.

Upright, composite pinnate colonies with polysiphonic branched stem. The apophyses of the stem (the primary tube) bear hydrocladia from which secondary hydrocladia proceed, as a rule from the first hydrotheca-bearing internodium. The apophyse lacks sessile sarcotheca. All the sarcothecæ are mobile and two-chambered.

It is not without hesitation that I retain this genus beside *Plumularia*, with which it is closely related; it may be a question whether we should here, more than in other cases, base the generic division upon the form of ramification. That I have retained it for the present as a separate genus is due to the fact that its species, from their peculiar appearance, form a well-defined group, sharply distinguished from the remaining ones which have been included in the genus *Plumularia*. My material is not so extensive as to suffice for a revision of the entire family, a task which becomes more and more imperative as further species continue to appear in the literature. A work such as

¹ Nutting has (1900 p. 83) by a slip of the pen called the genus *Polyplumularia*.

that of Nutting (1900) shows more than most how absolutely indispensable such critical revision really is. It is therefore most correct here for the present to retain a genus such as *Polyplumaria*.

***Polyplumaria frutescens* (Ellis et Solander).**

1786 *Sertularia frutescens*, Ellis and Solander, The natural history of many curious and uncommon Zoophytes, p. 55, pl. 6, fig. *a*, *A*, pl. 9, fig. 1.

The colonies are upright and singly or doubly pinnate, with polysiphonic hydrocaulus. The primary stem tube bears on its front a series of hydrothecæ, one to three on each internodium; at the base of each hydrotheca, the tube has an apophyse, which is directed obliquely forward and to the side, alternating to either edge. The apophyse bears a hydrocladium, as a rule secondarily branched, which is at first directed obliquely upward and forward, but gradually turns into the broad plane of the colony. The hydrocladium is divided by transverse nodes into internodia, bearing one to several hydrothecæ, and around this a pair of supracalcine sarcothecæ, and one median, unpaired, under the base of the hydrotheca. The hydrotheca is fairly large, slender, and fused throughout the whole of one side with the internodium. The secondary hydrocladia proceed from under the base of the basal hydrotheca of the primary hydrocladia, and assume the same appearance as the primary hydrocladia.

The gonothecæ are set on the branches without special protective organs. They are pear-shaped, cut off obliquely distally, with a large lid-bearing opening.

Material:

"Ingolf" St. 54 63°08' N., 15°40' W., depth 691 fathoms 3,9°

— - 55 63°33' N., 15°02' W., — 316 — 5,9°

The Faroe Islands: 61°40' N., 7°40' W., — 135 —

16 miles E. by S. of the south point of Nolsö, depth 80 fathoms.

Polyplumaria frutescens has its chief occurrence in the lower parts of the littoral region, and in the upper portion of the abyssal. It is a southern visitor to the boreal seas, having only on a single occasion been encountered in colder water layers, viz. east of Iceland (fig. XXVII). In Greenland waters, the species has not yet been found, and its occurrence at the Faroe Islands is here recorded for the first time.

***Polyplumaria flabellata* G. O. Sars.**

1874 *Polyplumaria flabellata*, G. O. Sars, Bidrag til Kundskaben om Norges Hydroider, p. 93, pl. 2, figs. 16—22.

Upright, doubly pinnate colonies with polysiphonic branched main stem. The primary tube bears on its internodia alternating apophyses, directed obliquely forward and upward. From the apophyse proceed the primary hydrocladia, which soon curve into the broad plane. The hydrocladia are divided by almost transverse nodes into internodia, each bearing a large hydrotheca, a pair of supracalcine sarcothecæ, a larger, unpaired proximal, and a smaller unpaired distal sarcotheca in the median line. The hydrothecæ are fairly large, about half as long as the internodium; the adcauline wall has a free portion in length about equal to the opening diameter, between one and two thirds of the length

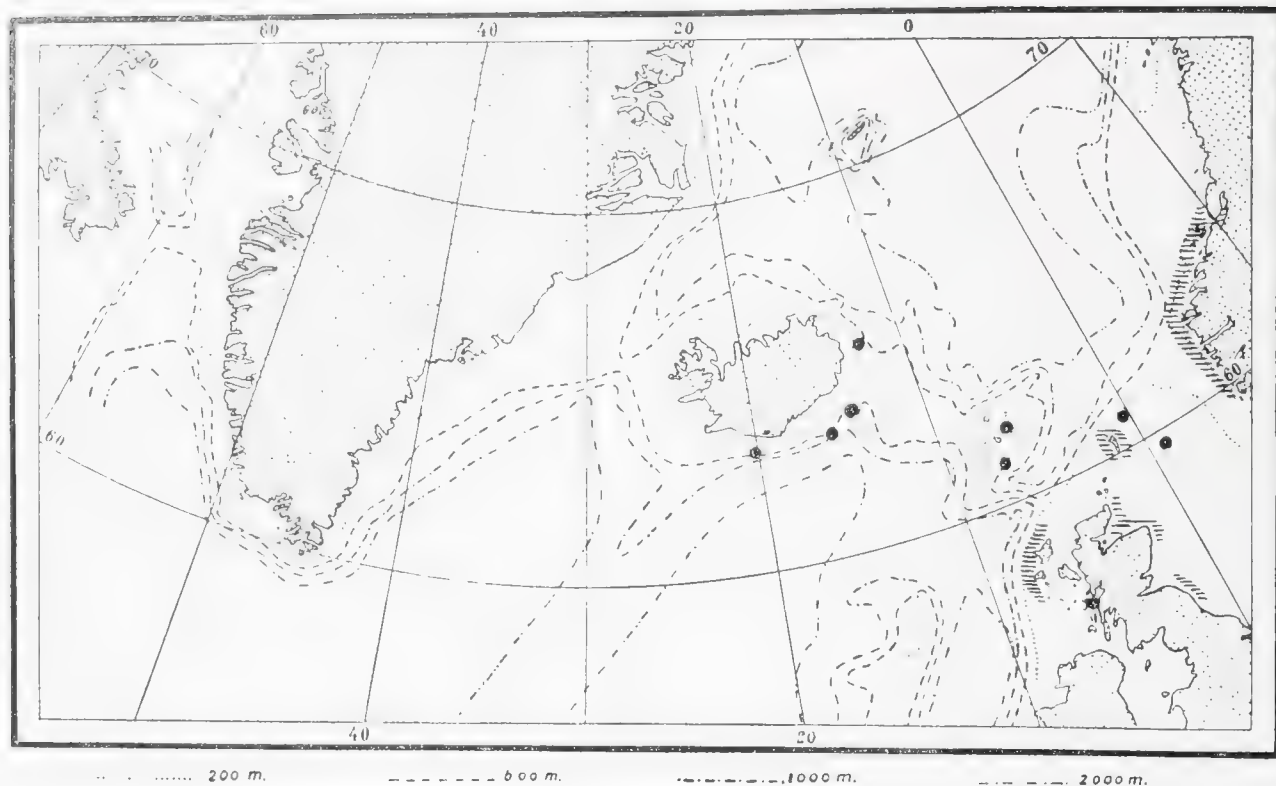


Fig. XXVII. Localities of *Polyplumaria frutescens* in the Northern Atlantic.

In the hatched parts the literature notes a scattered occurrence without further data.

of the hydrotheca. The secondary hydrocladium proceeds from beside the basal hydrotheca of the primary hydrocladium, and is of the same appearance as this.

The gonothecæ are fastened to the stem or the branch apophyses by a very short stalk. They are oval, with a large, somewhat asymmetrical distal opening, and with four sarcothecæ at the base. Material:

"Thor" 35°57' N., 5°35' W., depth 740 metres

Iceland: Vestmanö, — 510 —

According to Ritchie (1911 p. 223) the number of unpaired small distal sarcothecæ on the internodium should vary from one to three. No such variation could be discerned in the colonies investigated by me.

Polyplumaria flabellata is a very rare visitor in the northern waters (fig. XXVIII) and occurs here only in the deeper water layers. The species has altogether its main distribution in the upper parts of the abyssal region. The Vestmanna Islands mark the most northerly point where it has been found up to now; in Greenland waters it would seem to be entirely lacking.

Polyplumaria profunda (Nutting).

1900 *Plumularia profunda*, Nutting, Plumularidae, p. 66, pl. 8, figs. 2—3.

Upright, composite pinnate colonies with branched polysiphonic main stem. The primary tube which is seen in the outer parts of the colony is divided by transverse nodes into internodia, bearing

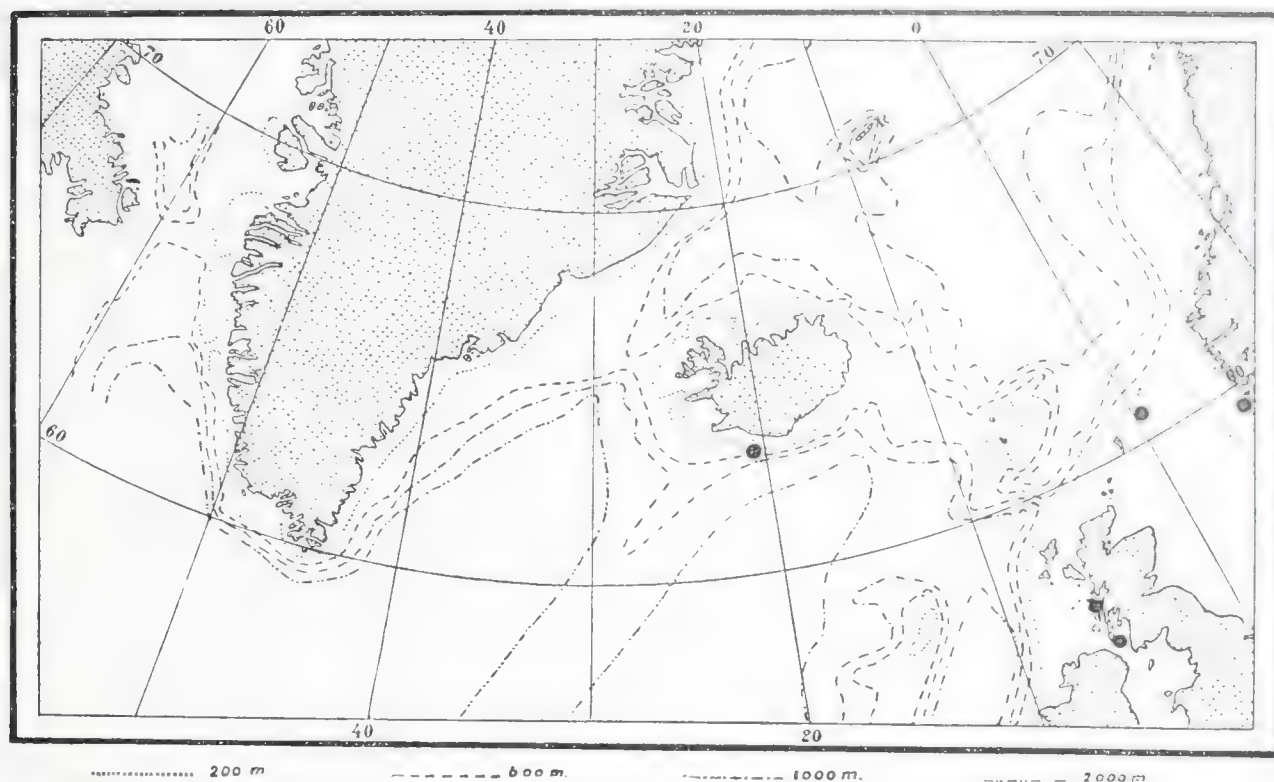


Fig. XXVIII. Finds of *Polyplumaria flabellata* in the Northern Atlantic.

one or two alternating apophyses. The apophyse proceeds asymmetrically from the base of a cauline hydrotheca; this is surrounded by a pair of supracalcine sarcothecæ, and a third sarcotheca situate proximally and a little to the side of the median line, somewhat removed from the base of the hydrotheca, on the side of the median line opposite to the apophyse. The hydrocladia are divided by transverse nodes into internodia, which have about the middle a hydrotheca with a supracalcine pair of sarcothecæ, on low apophyses near the opening of the hydrotheca, and a proximal, unpaired sarcotheca in the median line near the proximal end of the internodium. The basal internodium on the primary hydrocladium has two proximal unpaired sarcothecæ in the median line; at the base of this internodium's hydrotheca there appear, in fertile colonies, apophyses to the secondary hydrocladium, which is of the same structure as the primary. The hydrothecæ are on the hydrocladium about twice as long as broad; on the stem somewhat shorter; they have a somewhat outward curving opening margin, and are fused throughout their whole length with the internodium.

The gonothecæ are situate on the stem or close under the base of the proximal hydrothecæ on the primary and secondary hydrocladia; they have a short, often rudimentary stalk. The gonothecæ are pear-shaped, often curved, rounded off somewhat asymmetrically distally, with a broad opening; they have two sarcothecæ basally.

Material:

"Ingolf" St. 24	63°06' N.,	56°00' W.,	depth 1199 fathoms	2,4°
— - 55	63°33' N.,	15°02' W.,	— 316 —	5,9°
— - 98	65°38' N.,	26°27' W.,	— 138 —	5,9°

That Nutting (1900 p. 66) should refer this species to *Plumularia* must be due to his having had small or poorly developed colonies to deal with. From the "Ingolf" St. 55 we have a couple of splendid colonies showing the typical secondary hydrocladia of *Polyplumaria* in practically every branch, and richly furnished with gonangia. These are situated on the basal part of the hydrocladia — both primary and secondary, and partly also on the tubes of the stem.

It might be imagined that the present specimens, with their typical *Polyplumaria* colonies, were specifically different from Nutting's *Plumularia profunda*. We found, however, besides the two mentioned, extremely luxuriant colonies, also a smaller, single pinnate colony, where only the basal hydrocladia were furnished with secondary hydrocladia, all the remaining hydrocladia being simple. Nevertheless, this colony is likewise fertile, and a further investigation of the larger colonies shows that here also the secondary hydrocladia are lacking on several branches. In all these colonies, the stem is polysiphonic. But from the "Ingolf" St. 24 we have a quite young, sterile colony, where the whole stem is monosiphonic; only at the bottom of the basal part is a secondary tube developed. Here then, we have the complete transition from Nutting's description to the typical *Polyplumaria* which the species represents in its fully developed form. The resemblance in detail will furthermore be seen from a comparison of the illustrations here given (fig. XXIX).



Fig. XXIX.
Polyplumaria profunda "Ingolf" St. 24.
 a. Hydrocladial internodium. b. Internodium
 of the primary stem tube, with apophyse. ($\times 60$).

The finding of *Polyplumaria profunda* in the northern Atlantic is highly interesting. The species is a typical deep sea form, previously known only from West Indian waters. We now find, that it penetrates in deep water right up into Davis Strait and Danmark Strait, and to the southern slope of the Iceland region, where the warm and salt Atlantic water predominates. It is evidently not able to pass over the submarine ridges or into strictly boreal waters.

Nemertesia Lamouroux.

Upright colonies with as a rule pronounced main stem, which may be branched or unbranched, generally articulated and furnished with strong apophyses bearing finely built hydrocladia. The hydrocladia are single, unbranched. The colonies are furnished with stalked, two-chambered and mobile sarcothecæ, and have in addition, on each apophyse at its upper side where it proceeds from the stem, a large sessile sarcotheca ("mamelon"). The hydrocladia are segmented, and have several hydrothecæ, which as a rule are fused throughout their entire length with the branch. The hydrocladia are generally situated in several rows in fully developed colonies.

Formerly, in drawing the limits for this genus, the principal stress was laid on the fact that the hydrocladia are in multiserial arrangement, not merely in two rows as in *Plumularia*. This cannot

however, be admitted as a particularly important feature in generic distinction, as will be seen from a closer study of the *Nemertesia* species and their development. A species such as *Nemertesia tetrasticha* (Meneghini) differs in reality but little from the pure *Plumularia* type, its four-rowed appearance being due to a slight alternating displacement of the apophyses on the two sides; we have here then, as a matter of fact, two-rowed colonies, which have probably when younger been of the pure *Plumularia* form. In *Nemertesia ramosa* (Lamarck) I have in a previous work (1912 p. 5) pointed out that the distal parts of the colony not infrequently exhibit a purely biserial arrangement of the hydrocladia; the present material shows that small colonies both of this species and of *Nemertesia antennina* (Linné) are altogether biserial. Here, as a matter of fact, it is quite another character which warrants the generic identity, to wit, the large sessile sarcotheca ("mamelon") of the apophyse, which occurs in the colonies from the earliest stages onwards.

The development of the colonies, and the grown colonies themselves, clearly show that the multiserial arrangement of the hydrocladia is a secondary adaptation which is, moreover, in many species, subject to great variation within one and the same colony. The number of branch series is even variable in the single species, as in *Nemertesia ramosa*, where it varies from two to eight, or *Nemertesia antennina*, where we find from four to twelve. It is not easy to see why it should be more reasonable and effective to draw the limit between biserial and multiserial than for instance between quadriserial and multiserial. On the other hand, there is one constant feature in all the species hitherto noted under this genus; to wit, a peculiar large sessile sarcotheca on the apophyse. A comparison with other species (see for instance more particularly *Aglaophenopsis cornuta*) suggests that this formation should in reality be regarded as an abortive hydrotheca. In most cases, it forms a rounded raised portion, with circular opening, happily described by the French writers as a "mamelon". This sarcotheca occurs in colonies from the smallest to the largest in the same manner, whether the species is biserial or multiserial. It must thus be regarded as of generic importance. Consequently, we must reject from *Plumularia* those species which are furnished with a "mamelon" on the apophyse and have unbranched hydrocladia, placing them instead under *Nemertesia*.

We thus obtain, in this genus, biserial and multiserial forms. It is impossible to determine, from the data available, whether a species like *Nemertesia caulitheca* (Fewkes) (= *Plumularia caulitheca*, Nutting 1900 p. 63) is a young stage or not; its gonangia have not yet been discovered, and it may possibly be found to go through a development similar to that of our northern species, passing gradually from a biserial type over into the multiserial form. If not, then it must be regarded as a primitive species. The next stage is represented by *Nemertesia tetrasticha* (Meneghini), with its alternately displaced apophyses in the two branch rows; *Nemertesia ramosa* undergoes this stage, and probably also *Nemertesia antennina*, the former, however, at any rate soon proceeding further with a marked twist of the internodia, so that the apophyses in one internodium are perpendicular to those of the previous and subsequent ones. Not until later do further apophyses appear at the same level as the first, and from now onwards we regularly find, owing to the revolved position, a number of branch series divisible by two.

The nature of the stem has also served as basis for a division of the genus; here again, however, there is no real difference of principle to work on. The younger stages of *Nemertesia ramosa*

have monosiphonic stem; not until later does it become canaliculate, and finally, in fully developed colonies, we find purely polysiphonic basal parts of the stem, where secondary tubes cover the canaliculate central tube. Thus the limits between *Nemertesia* and *Antennopsis* become effaced, and these genera must in consequence, as I have previously maintained (1912 p. 28), and as Stechow also points out (1913 p. 25) be united into one. Similarly it follows, that Stechow is correct in placing *Sibogella* under *Nemertesia*.

Bedot, in a work which has just appeared (1917) treats of the genus *Nemertesia* at length, unfortunately, however, without giving any synopsis of the generic characters. It is nevertheless clear that Bedot inclines to regard the canaliculate ("pluricanaliculée") stem as a family trait. The character

is developed, as mentioned above, only in somewhat larger colonies — generally at least 5 cm high — it is moreover often lacking in large distal parts of the colony in the northern species, where the stem frequently retains its primary ("unicanaliculée") character. And finally, the primary "pluricanaliculée" stem tube is secondarily covered, as in *Nemertesia ramosa*, by tubes "unicanaliculées" to a greater or lesser extent. This in itself detracts from the value of the character in question. But in addition, it is also found to stand in a certain relation to the dimensions of the stem tube; thick, single stems are "pluricanaliculées" in species within the same genus, where the thin ones are constantly "unicanaliculées" (cf. for instance *Tubularia*). As a matter of fact, the two types "fasciculée" (polysiphonic) and "pluricanaliculée" (canaliculate) represent parallel processes of development towards the same end. And as we are unable to take the former as basis for generic distinction, so also the latter character must be considered quite inadequate as a

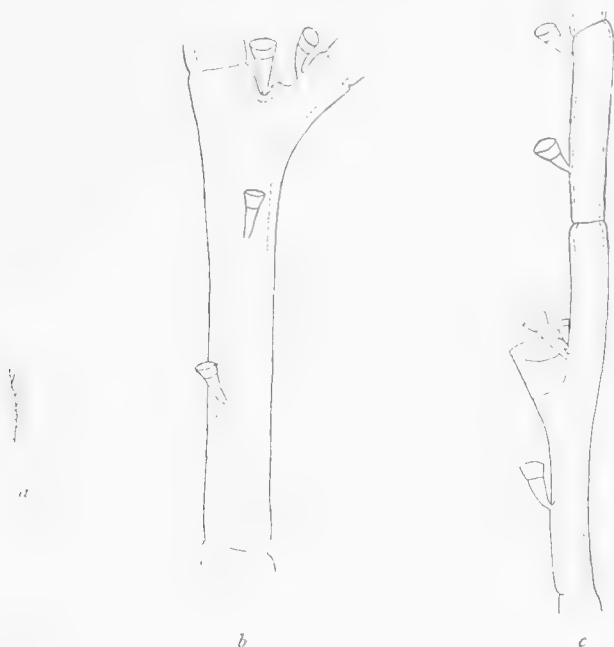


Fig. XXX a—c. *Nemertesia antennina*, juv. "Ingolf" St. 98. a. The entire colony (nat. size). — b. Internodium of the hydrocaulus with the hydrocladial apophyse, showing the sessile sarcotheca. — c. Two successive internodes of a hydrocladium (b and c $\times 80$).

means of distinguishing between genera (or families).

Nemertesia antennina (Linné) Lamouroux.

1758 *Sertularia antennina*, Linné, *Systema naturæ*, ed. 10, p. 811.

1812 *Nemertesia antennina*, Lamouroux, *Extrait d'un mémoire sur la classification des polypes coralligènes*, p. 184.

Colonies with unbranched or quite exceptionally slightly branched canaliculate and segmented stems. The apophyses are set in circles on the internodium, each circle containing three to six or even more apophyses; the internodia are revolved, so that the stem has twice the number of longitudinal rows of apophyses. Near its point of origin, the apophyse has on its upper side a comparatively small, sessile sarcotheca ("mamelon") and two or three irregularly arranged, stalked and two-chambered

mobile sarcothecæ. The hydrocladia are divided by transverse nodes into internodia of which normally every second one bears one or two unpaired sarcothecæ in the median line, the alternate ones having a small hydrotheca with a supracalycine pair of sarcothecæ at the mouth, and an unpaired median sarcotheca on the proximal part of the internodium. The hydrotheca is about $\frac{1}{5}$ to $\frac{1}{3}$ the length of the internodium, and is on one side entirely fused therewith.

The gonothecæ are attached by an almost rudimentary stalk to the apophyses; they are oval to pear-shaped, with a distally laterally placed asymmetrical opening.

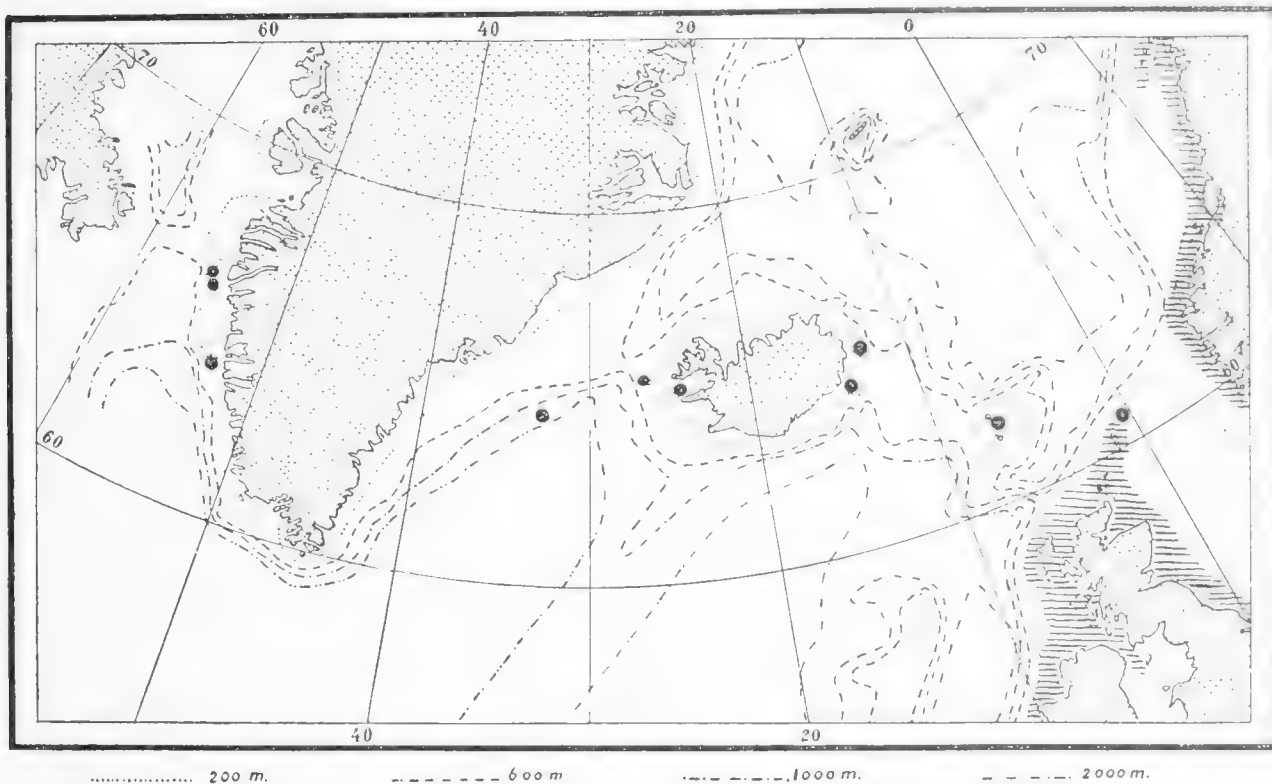


Fig. XXXI. The distribution of *Nemertesia antennina* in the Northern Atlantic.

In the hatched parts the literature notes a scattered although common occurrence.

Material:

"Ingolf" St. 87, 65°02.3' N., 23°56.2' W.; depth 110 fathoms

— - 92, 64°44' N., 32°52' W.; — 976 — 1.4°

— - 98, 65°38' N., 26°27' W.; — 138 — 5.9°

Greenland: Davis Strait, — 80 — (without further details)

— — 65°27' N., 54°45' W.; — 67 —

Iceland: 5 miles E. of Seydisfjörð, — 135 —

The Faroe Islands: Deep hole at the north point of Nolsö, depth 100 fathoms.

Some luxuriant colonies from Davis Strait exhibit interesting variations in the number of hydrocladia. The nodes of the stem are slightly marked, and each internodium bears but three apophyses; owing to the revolution of the internodia therefore, these colonies or parts of colonies are six-rowed; among these colonies again there are others, or in the single colony, other parts, which in a

similar manner appear eight-rowed, with four apophyses in the circle. The same octoserial type was met with at the "Ingolf" St. 87, and from St. 92, we have for the first time specimens with six apophyses in each circle, giving a twelve-rowed colony. The revolution of the segments is thus characteristic of grown colonies, and calls to mind the features noted in *Nemertesia ramosa* (cf. Broch 1912 p. 5).

From St. 98, the "Ingolf" brought a young specimen of *Nemertesia antennina* which is of considerable interest (fig. XXX). The colony is still quite biserial, and can only be distinguished from *Plumularia* by the sessile "mamelon" of the apophyses. As however, the arrangement of the sarcothecæ and hydrothecæ entirely agrees with *Nemertesia antennina*, I have no hesitation in referring the colony to this species, the more so since altogether parallel stages occur in the following species together with later phases of development.

Nemertesia antennina is a southern form with wide distribution in the boreal region (fig. XXXI). Towards the south, it goes at any rate as far as Madeira, and is common in the Mediterranean; it belongs to the middle and lower parts of the littoral region, but may exceptionally, as shown by the finds from the "Ingolf" St. 92, go deep down into the abyssal. It has not yet been met with in purely arctic waters, unless the one find from the east coast of Iceland should be so described.

***Nemertesia ramosa* Lamouroux.**

1816 *Nemertesia ramosa*, Lamouroux, Histoire des Polypiers coralligènes, p. 164.

1903 *Antennularia variabilis*, Broch, Die von dem norwegischen Fischereidampfer "Michael Sars" gesammelten Hydroiden, p. 10, Taf. IV, figs. 22—25.

Colonies with branched main stems, polysiphonic in their lower parts, canaliculate in the upper. Apophyses form circles about the internodia of the stem, two to four in each circle, and the internodia are revolved, giving twice the number of longitudinal rows. In the lower parts of the colonies, where secondary tubes cover the primary stem, the circular arrangement of the branches is less distinctly marked. The apophyse has on its upper side a strong, narrow, but high sessile sarcotheca ("mamelon") and 3—4 irregularly placed, mobile sarcothecæ. The hydrocladia are divided by transverse nodes into internodia, each of which has a median hydrotheca with a supracalcine pair of sarcothecæ at the opening, and one proximal and one distal unpaired sarcotheca in the median line; exceptionally, the distal part with its sarcotheca may be divided by a slight joint from the main internodium. The hydrotheca is entirely fused with the hydrocladium, and is $\frac{1}{6}$ to $\frac{1}{3}$ the length of the internodium.

The gonothecæ are attached to the apophyse by a short, almost rudimentary stalk. They are oval to pear-shaped, with a distally lateral asymmetrical opening.

Material:

"Ingolf" St. 55	63°33' N.,	15°02' W.;	depth 316 fathoms,	5,9
—	- 85	63°21' N.,	25°21' W.,	— 170 —
"Thor"	61°15' N.,	9°35' W.;	—	872 metres
Iceland: Vestmanö,			—	50 fathoms
The Faroe Islands:	62°16' N.,	6°06' W.;	—	110 metres
	60°55' N.,	8°56' W.;	—	840 —

6 miles N. by W. of Store Kalsö,	depth	60 fathoms	
Deep hole at the north point of Nolsö,	—	100	—
1,5—2 miles off the mouth of Borövig,	—	20—30	--
Prövenæs 13 miles in N.75°W.,	—	30	
Borönæs in N.75°W.,	—	30	—
The Faroe Islands,	—	30	— { (without further details).

Nemertesia ramosa is extremely variable as regards arrangement and number of the hydrocladia, as I have previously (1912 p. 5) had occasion to explain. In the revolution of the internodia, however, it follows the same regular principles as *Nemertesia antennina*. The structure of the stem presents

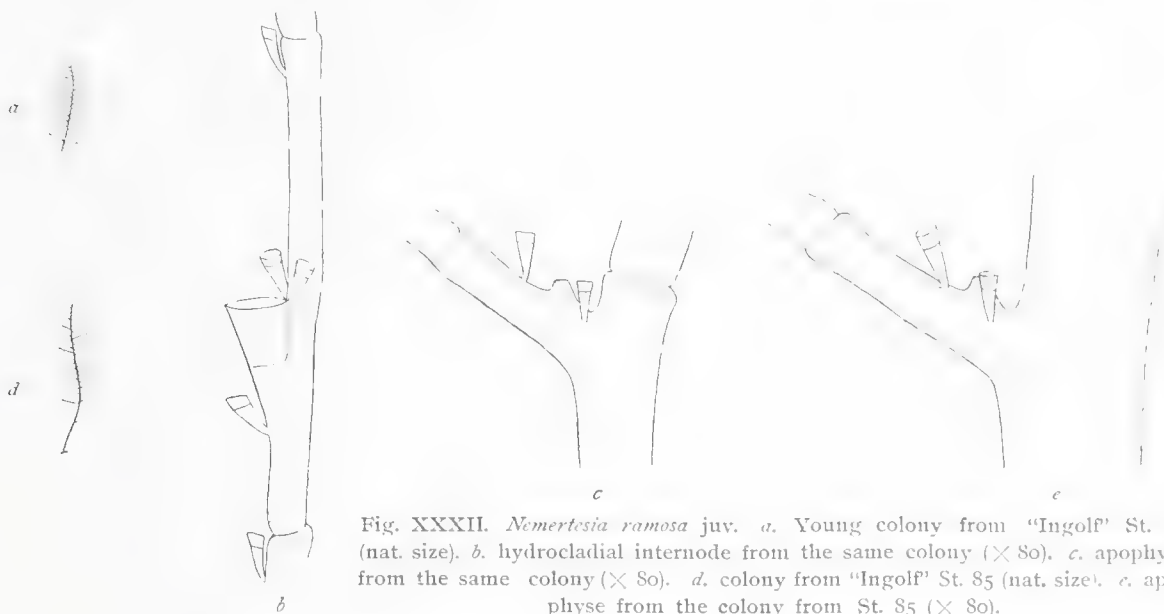


Fig. XXXII. *Nemertesia ramosa* juv. a. Young colony from "Ingolf" St. 55 (nat. size). b. hydrocladial internode from the same colony ($\times 80$). c. apophyse from the same colony ($\times 80$). d. colony from "Ingolf" St. 85 (nat. size). e. apophyse from the colony from St. 85 ($\times 80$).

features of considerable interest. The distal part of its ramifications exhibits the same structure as *Nemertesia antennina*, having, inside the homogeneous peridermal chitinous sheath, coenosarc strings; these parts of the stem are thus canaliculate. Farther down, however, we find secondary tubes closely arranged about the primary stem tube, and the nearer we come to the base, the closer is the network and the thicker the stem. Where these secondary tubes occur, they cover the apophyses more and more, finally burying them altogether, while the hydrocladia here also fall away. Consequently, the basal part of well-developed colonies of *Nemertesia ramosa* lacks hydrocladia, whereby the colony assumes a highly peculiar appearance.

At a couple of the "Ingolf" stations, some quite small colonies of *Nemertesia ramosa* were found; these serve well to show the difficulty of distinguishing the young stages from *Plumularia* (fig. XXXII). The smallest colony (a) is altogether pinnate; the thin stem is divided into irregular internodia with a varying number of apophyses, but closer investigation shows that the apophyses do not form two regular longitudinal rows, being as a matter of fact alternately somewhat displaced to one side or the other, so that we have here a slight approach to quadriserial arrangement. A somewhat larger colony (d), where the stem is slightly thicker, reveals more clearly the displacement of

the apophyses, which is here evident at the first glance. In this case, it would scarcely be possible for anyone to doubt that the specimen is a young *Nemertesia*, the more so since the stem is strikingly thick. Further confirmation is in both instances afforded by the branch apophyses (*c* and *e*); in both colonies we find the characteristic "mamelon" on the upper side of the apophyse, close to the stem, which proves that they belong to the *Nemertesia*. The entire arrangement of the hydrothecæ and sarcothecæ also shows that the species is *Nemertesia ramosa*.

The stages found already show that the younger *Nemertesia* are throughout constructed after the *Plumularia* type, with biserial apophyses, and that *Nemertesia* must be derived from *Plumularia*. It would further seem to suggest that *Plumularia caulithecæ* Fewkes is probably a young stage of a

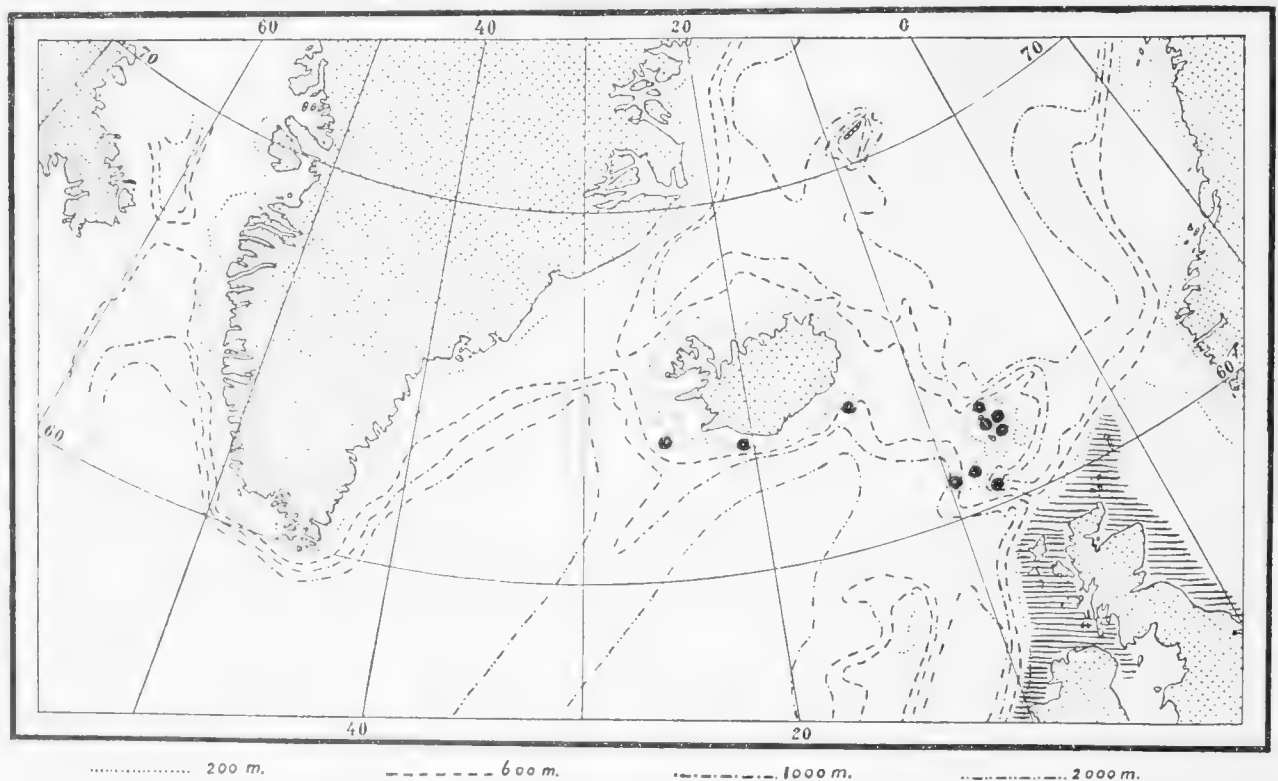


Fig. XXXIII. Occurrence of *Nemertesia ramosa* in the Northern Atlantic.

In the hatched region the literature notes a common occurrence.

Nemertesia. And it is likely that also other *Plumularia* species in reality cover young *Nemertesia* species, and should, from the presence of a "mamelon", be transferred to that genus.

Among the synonyms of *Nemertesia ramosa* should also be reckoned *Antennularia variabilis* Broch. The defective specimens, where only the chitinous parts are preserved, have lost all their sarcothecæ, so that only a hole in the periderm, or a slightly raised part here and there, shows where the sarcothecæ have been. The difficulty of discerning these remains has led to their being regarded as variable in number, and the remains or traces of supracalcine sarcothecæ had altogether escaped attention. Otherwise the colonies agree entirely with *Nemertesia ramosa*, and must thus be referred to that species.

Nemertesia ramosa has its chief occurrence in the littoral region, especially in the middle and

lower parts of the same; it has been met with once or twice quite deep down in the abyssal region, as for instance on the "Thor" expedition, when it was taken near the Faroe Islands at 872 metres, probably the greatest depth from which the species has hitherto been recorded. *Nemertesia ramosa* belongs to the warmer parts of the Atlantic, and penetrates thence (fig. XXXIII) in great numbers into the southern part of the boreal region. The species has not hitherto been found in Greenland waters, but is recorded from one or two places on the south coast of Iceland. Round the Faroe Islands, it is seen to be of very frequent occurrence, and is said by Hincks (1868 p. 283) to be more numerous even than *Nemertesia antennina* on the coasts of Scotland. The species has not yet been located with certainty on the Norwegian coasts, but its occurrence in the Skagerak (Broch 1905 p. 24) and Bohuslän (Jäderholm 1909 p. 105) suggests that it will probably be found to occur there.¹

Polynemertesia nov. gen.

Upright colonies with distinct, branched main stem, exhibiting segmentation in its monosiphonic parts; the stem is furnished with alternating strong apophyses which bear finely built hydrocladia. The hydrocladia are secondarily branched. The apophyses — both those of the primary and those of the secondary hydrocladia — are furnished on their upper side, near the point of origin, with a short sessile sarcotheca, "mamelon"; all the remaining sarcothecæ are mobile. The primary and secondary hydrocladia are segmented, and bear several hydrothecæ, which are as a rule fused throughout their entire length with the branch.

It is with considerable hesitation that I have established this new genus for *Plumularia gracillima* G. O. Sars. Previous investigators have overlooked the presence of a "mamelon" on the apophyses, in virtue of which the species must be separated from the *Plumularia*. With its secondary ramification of the hydrocladia, however, the species stands in the same relation to *Nemertesia* as *Polyplumaria* to *Plumularia*. A separation of the two latter genera therefore logically demands a like separation between the parallel groups of *Nemertesia* and *Polynemertesia*. The fact that the primary apophyses in the only known species are biserially arranged on the hydrocaulus must be regarded as of minor importance.

It might be thought more reasonable here to revive an older name for the genus in question; it should then be *Diplopteron* or *Schizotricha*. The former, however, has already been withdrawn by Allmann himself (1883 p. 30) as synonymous with *Polyplumaria*; Nutting's attempt to revive it (1900 p. 81) can only be explained as due to his having taken as basis for the generic division a character which should otherwise be used only with caution even in distinction between species, as in all probability, it would seem that the type species for *Polyplumaria* and *Diplopteron* are very nearly identical. And with regard to *Schizotricha* it should be borne in mind that both the two species originally placed by Allman (1883 p. 28) in this genus must be referred to *Polyplumaria*. It would thus be incorrect to take as the type a species which has not from the first been ascribed to this genus; *Plumularia gracillima* G. O. Sars is first placed under this head by Nutting (1900 p. 80). Of the remaining species which have been referred to this genus, *Schizotricha bifurca* Hartlaub and *Schizotricha*

¹ After the close of the manuscript a find of the species in the Trondhjem fjord has proved the correctness of this supposition.

antarctica Jäderholm must doubtless be removed to a genus of their own, more closely related to *Kirchenpaueria*. It would thus not be advisable to introduce a new diagnosis for *Schizotricha*; the genus should rather be allowed to disappear definitely as synonymous with *Polyplumaria*, which latter generic appellation is older, and originally better defined. For *Plumularia gracillima* G. O. Sars therefore, it will be best to take an entirely new generic name.

***Polynemertesia gracillima* (G. O. Sars).**

1873 *Plumularia gracillima*, G. O. Sars, Bidrag til Kundskaben om Dyrelivet paa vore Havbanker, p. 86.

1893 *Plumularia groenlandica*, Levinsen, Meduser, Ctenophorer og Hydroider, p. 63, tab. VIII, figs. 10—12.

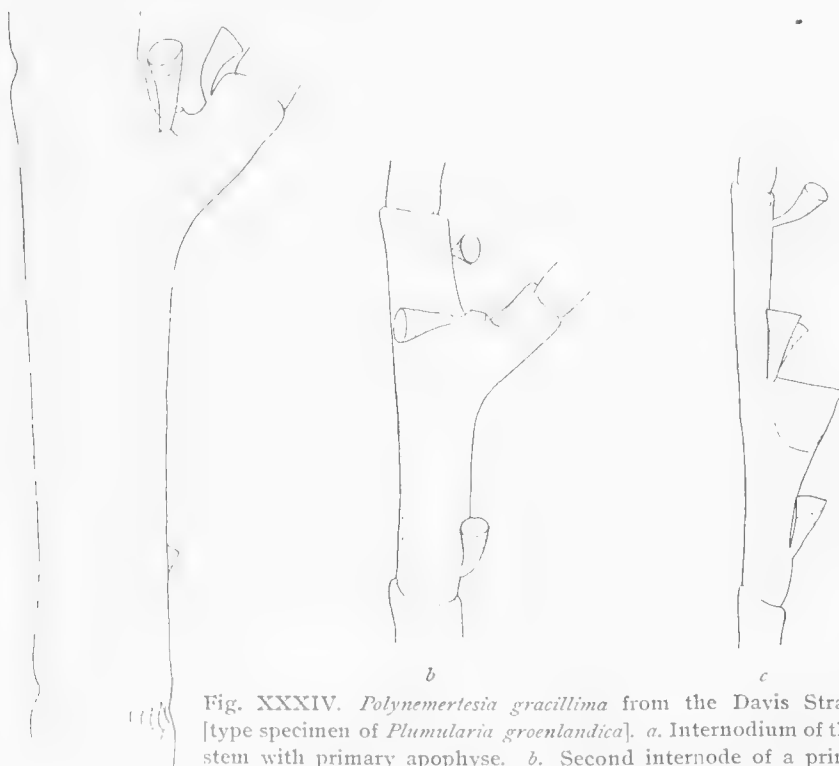


Fig. XXXIV. *Polynemertesia gracillima* from the Davis Strait [type specimen of *Plumularia groenlandica*]. *a*. Internodium of the stem with primary apophyse. *b*. Second internode of a primary hydrocladium with secondary apophyse, showing a distinct "mamelon". *c*. Hydrothecate internode. ($\times 80$).

Single pinnate colonies with monosiphonic or in the basal parts polysiphonic main stem. The monosiphonic stem is divided by transverse nodes into internodia, which bear distally a short apophyse, directed obliquely forward, turning alternately to either side of the median line. The stem has no hydrothecæ, but bears mobile sarcothecæ, two unpaired, somewhat asymmetrically arranged on the basal part of each internodium. The apophyse has a "mamelon" on its upper side near the stem; beside this on the rear side a mobile sarcotheca, and also an unpaired mobile sarcotheca distally in the median line. The apophyse bears a secondarily branched hydrocladium; the hydrocla-

dium is divided by transverse nodes into irregular internodia, of which every alternate one bears two unpaired sarcothecæ in the median line, every other a median hydrotheca, a supracalcine pair of sarcothecæ at the opening of the same, and an unpaired proximal, and as a rule an unpaired distal sarcotheca in the median line; on the distal parts of the hydrocladia the hydrothecaless internodium often melts into the hydrotheca-bearing internodium. The basal internodium of the hydrocladium is hydrotheca-bearing; the following small internodium is furnished at the middle with an apophyse directed obliquely forward and bearing the secondary hydrocladium; from the second segment of the latter there proceeds as a rule a further hydrocladium in the same manner; these secondary (tertiary) apophyses also are provided with a "mamelon" and two mobile sarcothecæ, as in the case of the primary apophyse. The secondary hydrocladia are of the same structure as the primary. The hydrothecæ are small, with slightly outward curving opening margin, and are throughout their entire length fused with the internodium.

The gonothecæ are attached to the apophyse beside the sessile sarcotheca. Fully grown gonangia have not yet been found.

Material:

"Ingolf" St. 27 64°54' N., 55°10' W., depth 393 fathoms 3,8°

— - 34 65°17' N., 54°17' W., — 55 —

Greenland: Davis Strait (without further details) [type specimens of *Plumularia groenlandica*].

Iceland: Ingolfshöfði 9½ miles in N. by E. ½ E., depth 53 fathoms.

Levinson (1893 p. 63) gives a very detailed description of this species, which he incorrectly regards as different from Sars's *Plumularia gracillima*. He has however, in common with others who

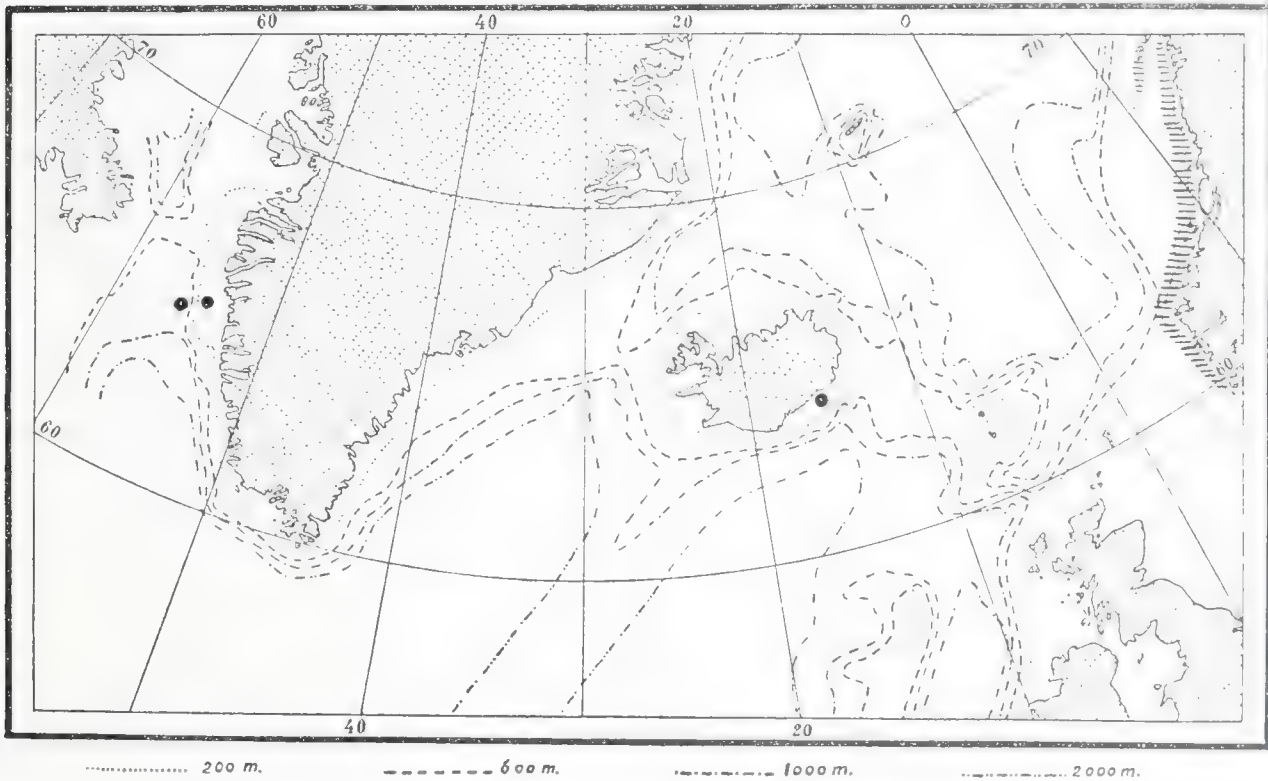


Fig. XXXV. The localities of *Polynemertesia gracillima* in the Northern Atlantic.

In the hatched region the occurrence according to the literature is common, although scattered.

have investigated the species, overlooked its typical sessile sarcotheca on the apophyses (fig. XXXIV). It is noticeable that a mamelon occurs not only on the primary but on all the apophyses in the colony. The idea that it should, as Nutting (1900) believes to be the case with other species, form the point of origin of the gonothecæ, is due to inadequate investigation; the gonothecæ have their point of attachment by the side of this sarcotheca. Levinson's description incorrectly gives the impression that he has had grown gonothecæ before him at the time; they are, however, only quite young stages, and grown gonangia have thus not been described for this species.

Polynemertesia gracillima is plainly a southern visitor to the northern waters, and has strangely enough not yet been recorded in the British waters (fig. XXXV). The "Ingolf" was able to furnish

further data as to the occurrence of the species at West Greenland, where it penetrates right into the Lille Hellefiskebanke. On a single occasion it has been found in Iceland waters. On the coast of Norway it has been met with now and then between Lofoten and Stavanger. It has also been found off Bohuslän (Jäderholm 1909 p. 108). The species belongs to the lower part of the littoral region, and the upper parts of the abyssal.

Family Aglaopheniidæ.

The hydrothecæ are large, with distinctly bilateral structure, sessile, and with the one side wholly or partly fused with the branches. The diaphragma is asymmetrical or bipartite. The polyps can retire altogether into the hydrothecæ. The sarcothecæ are sessile, immobile and well developed; exceptionally we may find, in addition, also mobile, stalked supracalcine sarcothecæ. The hydrotheca margin is as a rule furnished with teeth. The colonies are monopodial with terminal growth point. The endoderm of the polyps is divided into a fore-stomach and a digestive part; the ectoderm often gives off an ectoderm lamella which fastens the polyp to the ribs of the hydrotheca.

The division of this family is based chiefly upon the nature of the gonangia and the protective formations which are richly and variously developed in the different genera. Primitive in this respect is *Halicornaria*, from which the remainder are derived. On the one side, there is a development towards *Nematocarpus*, where the hydrocladia are secondarily branched, though without discernible relation to the gonangia. On the other arise, in all probability separately, the phylactogonia-bearing genera *Aglaophenopsis* and *Cladocarpus*, typical deep sea genera, of which the former has hydrotheca-bearing phylactogonia, the latter, on the other hand, only sarcotheca-bearing phylactogonia. Possibly also, the corbula-bearing genera *Thecocarpus* and *Aglaophenia* should be derived from these, but their origin is not yet certain.

Gen. *Halicornaria* (Busk).

Upright colonies with branched or unbranched main stem, the apophyses of which bear unbranched hydrocladia with several hydrothecæ. All sarcothecæ are immobile. The gonangia are situated on the stem or branches without protective organs of any kind.

Halicornaria campanulata (Ritchie).

1912 *Cladocarpus* (?) *campanulatus*, Ritchie, Some Northern Hydroid Zoophytes, p. 226.

The colony is doubly pinnate, with polysiphonic branched main stem, which consists in its extreme portions of the primary segmented tube alone. This has internodia of medium length, which bear about the middle a short, but quite broad apophyse; the internodium is further provided with a pair of sarcothecæ at the upper side of the apophyse, and an unpaired median sarcotheca in front at its lower side; the sarcothecæ are almost tubulous, adcaulinally split. The hydrocladia have on each internodium a broad, and not particularly large hydrotheca and three sarcothecæ; a supracalcine pair at the opening, and a median proximally, which with its opening margin reaches up to the bottom

of the hydrotheca. All the sarcothecæ are adcaulinally split, and have a slightly dentate margin. The hydrotheca is broad, and has a very slightly curved opening margin; its basal part has a somewhat thicker wall than the distal two-thirds, and the boundary between the two portions is apparent as a fine line abcladially directed obliquely forward towards the opening; hydrothecal ribs or septa lacking. The internodium shows two to four inner ribs at the adcladial side of the hydrotheca; one such, which is three-branched, and markedly prominent, forms a boundary between the proximal sarcotheca and the internodium.

The gonothecæ are situate on the stem at the apophyses. The young gonotheca shows distally a peculiar oblique termination, the one side of which gradually projects further forward, suggesting that the fully developed gonotheca would be furnished with a roof-like upper lip. Phylactogonia lacking.

Material:

"Ingolf" St. 127 66°33' N., 20°05' W., depth 44 fathoms, 5,6°
Iceland: Tistil fjord, 66°43' N., 14°53' W., — 78 —

Ritchie (1912 p. 226) refers this species to *Cladocarpus*, but with a query, as he did not find gonangia in his specimens. These agree entirely with the present colonies (fig. XXXVI) which, from the comparatively short, broad hydrothecæ, can hardly be confused with other species from northern waters. The colonies in question show that the species should be placed under *Halicornaria*. The gonangia occur in several stages of development, but none fully developed. The series of phases represented in the colonies investigated are entirely parallel to what we find in *Cladocarpus integer* (G. O. Sars); the oldest stage also seems to show that it develops, as does the species mentioned, an "upper lip" which will dome out more or less over the opening; further investigations must determine, how far the development proceeds.



Fig. XXXVI. *Halicornaria campanulata* from "Ingolf" St. 127. Hydrothecate internodium from a hydrocladium in side and front view. (× 60).

Phylactogonia are altogether lacking in the colonies here concerned, and the species must consequently be regarded as a *Halicornaria*; there is, however, the possibility that it may later prove to be a primitive *Cladocarpus*. The otherwise close resemblance of the species to *Cladocarpus integer* would also seem to point in the same direction; the last-named species has hitherto likewise been regarded as a *Halicornaria*, but, as is further explained below, it is as a matter of fact a primitive *Cladocarpus*, whose phylactogonia do not always or everywhere attain development. We cannot therefore altogether disregard the possibility that *Halicornaria campanulata* may also under normal conditions develop more or less regularly occurring phylactogonia. But as long as this has not been shown to be the case, the species must remain in the genus *Halicornaria*.

Ritchie (1912 p. 227) could not state the locality of origin of the species nearer than "from the neighbourhood of Iceland", which from a bio-geographical point of view is very meagre information indeed. The localities now recorded are the more surprising, since we should *a priori* suppose

that we have to deal with a form from the warmer Atlantic regions; both the finds are in fact from near the north coast of Iceland. At the same time, however, it should be noted that both are situated in water of positive temperature; at the "Ingolf" St. 127 no less than 5,6°; it is thus not impossible that the occurrence of the species here is due to larval transportation from the Danmark Strait. Arctic the species certainly cannot be; even the one *Aglaopheniid* hitherto found in any number in arctic water layers, *Thecocarpus myriophyllum* (Linné) is not indigenous there. We must therefore regard the *Aglaopheniidae* on the whole as southern visitors in the colder northern seas. *Halicornaria campanulata* must likewise be placed in this category; its true home, however, has yet to be discovered.

Nematocarpus nov. gen.

Singly or doubly pinnate colonies, the apophyses of the primary stem tubes bearing hydrocladia, which in fully developed colonies are secondarily branched. All sarcothecæ immobile. The secondary hydrocladium is formed from the proximal sarcotheca branch on the primary, and stands in no relation to the gonangia. The latter are not surrounded by any protective organs.

This peculiar genus is known only in a single species, originally described as a *Halicornaria* by Allman (1874 p. 477). In Nutting's diagnosis of this genus (1900 p. 126) we find "Hydrocladia not branched; hydrocladial internodes without septa". The latter point is of minor importance even in distinction of species, but the first-mentioned character is also adopted by Stechow (1913 p. 43) "Hydrocladien einfach".

On the other hand, we may with some justification maintain that the genus *Aglaophenopsis* (Fewkes) is based on forms with branched hydrocladia. We must, however, here note a great difference in comparison with *Halicornaria ramulifera* Allman; the secondary branches in *Aglaophenopsis* are hydrotheca-bearing phylactogonia, and stand thus in definite relation to the gonangia; in this case, however, they have nothing to do with the gonangia, and do not develop into minor branches, as in *Aglaophenopsis*, but into secondary hydrocladia of the same structure and appearance as the primary. This difference is important, inasmuch as we should, as Bale already (1887) pointed out, establish a new genus on the basis of the same. The nearest related genera are *Halicornaria*, *Aglaophenopsis*, and *Cladocarpus*, where we often, especially in the two last, find the same structure of the gonotheca as in the known *Nematocarpus* species.

Nematocarpus ramuliferus (Allman).

1874 *Halicornaria ramulifera*, Allman, Report on the Hydroida.... Porcupine, p. 477, pl. 67, fig. 3.

1903 *Halicornaria pluma*, Broch, Die von dem norwegischen Fischereidampfer "Michael Sars" gesammelten Hydroiden, p. 8, Taf. IV, figs. 15-21.

Doubly pinnate colonies, with somewhat irregularly branched, polysiphonic main stem. The primary tube is segmented, and has on the middle of each internodium a strong apophyse, directed alternately to each side, and a pair of sarcothecæ at the upper side of the apophyse; the sarcothecæ are adcaulinally split. From the apophyse proceeds a hydrocladium, bearing a hydrotheca on each

internodium, surrounded by a pair of supracalyceine sarcothecæ on the distal part of the internodium and an unpaired median proximally; between this and the base of the hydrotheca arises a sarcotheca-bearing branch, which bends forward over the hydrotheca, and has on its convex (outer) side a row of sarcothecæ. The sarcotheca-bearing branch of the basal hydrotheca develops into a secondary hydrocladium of the same appearance as the primary, but somewhat finer. Also in the exterior sarcothecal branches hydrothecæ may be developed. The hydrothecæ are fused throughout their basal half with the branch; the distal portion forms an angle with the basal, and widens somewhat towards the aperture. The margin is furnished with 9 or 11 teeth; a large median proximal (abcladial), beside this as a rule a couple of smaller ones, then two well marked, and finally there are distally (adcladially) a pair of large teeth of the same size as the proximal, and between them a couple of quite small ones.

The gonothecæ are attached by a short, often almost rudimentary stalk to the stem; viewed laterally, the gonotheca is asymmetrically egg-shaped or oval, with a distal lateral opening; seen from the front, they are oval, distally often broadly rounded; the aperture is round. At times there may be some approach to formation of an "upper lip" above the mouth.

Material:

"Ingolf" St. 44 61°42' N., 9°36' W., depth 545 fathoms 4,8°
 — - 98 65°38' N., 26°27' W., — 138 — 5,9°

The new colonies brought home by the "Ingolf" show that the *Halicornaria pluma* Broch (1903 p. 8) described as distinct species is really only a somewhat older stage of *Nematocarpus ramuliferus* (Allman); we have now colonies showing the next stages through which they pass over to the possession of secondarily branched hydrocladia (fig. XXXVII a). Here also the species retains its peculiar nude posterior side, whereas the front appears even more furry than in young colonies. There are certain signs which seem to indicate that a primary hydrocladium may bear several secondary ones. *Halicornaria pluma* was established chiefly on the strength of the fact that the basal sarcotheca-bearing branch of the hydrocladium has a hydrotheca, whereas the remaining sarcothecal branches lack hydrothecæ. The present colonies now show that this was merely the forerunner of the secondary hydrocladium, which gradually develops new hydrothecæ with sarcotheca-bearing branches outside the first¹. At the same time, however, we find a hydrotheca with its corresponding sarcothecal branch developed at the second, often also at the third hydrotheca, and it is therefore highly possible that in still larger colonies we may also here find developed secondary hydrocladia, showing that a primary hydrocladium can bear several secondary ones.

The gonothecæ are incompletely described both by Allman (1874 p. 477) and Broch (1903 p. 8) probably from imperfectly developed specimens. They are of very peculiar form (fig. XXXVII). They are attached by a stalk which is not infrequently very short, almost rudimentary. The one (adcauline) side is somewhat flattened and short, the other however, highly curved and a good deal longer, so that the plane of the aperture is almost or entirely parallel with the longitudinal axis of

¹ In fig. XXXVII a, the secondary hydrocladium shows only one complete sarcothecal branch (the basal); this is due to the fact that the two next are broken off. Ordinarily, they appear in fully normal development at every single hydrotheca.

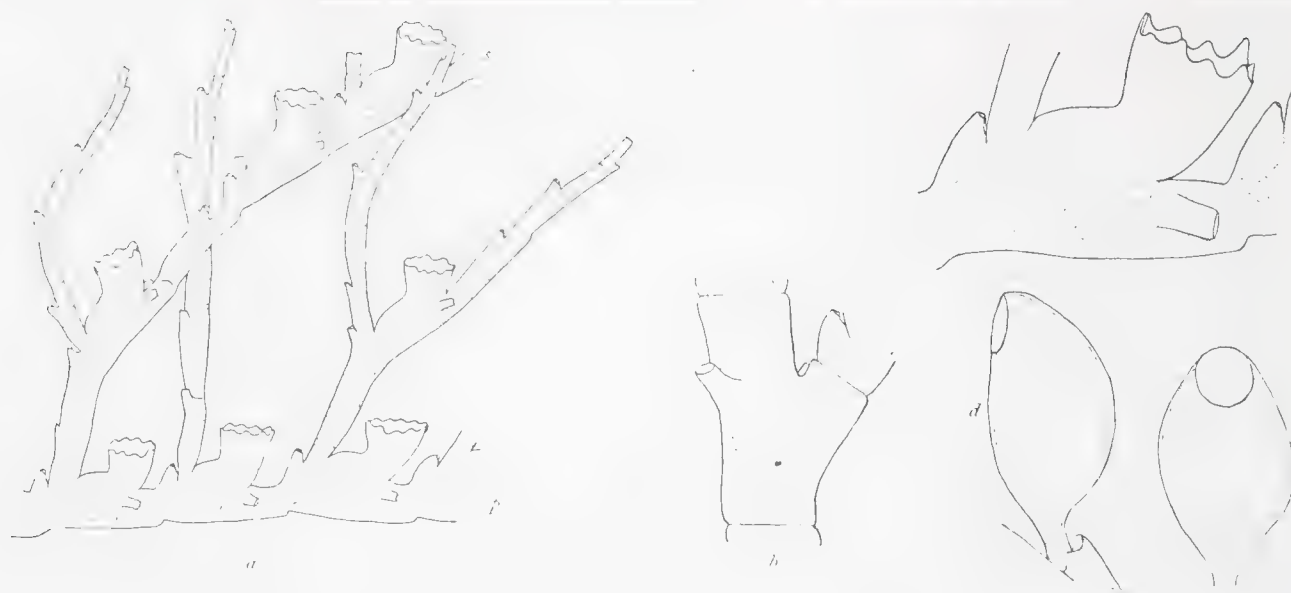


Fig. XXXVII. *Nematocarpus ramuliferus*. *a* basal part of a hydrocladium showing the development of the secondary hydrocladium [*p* primary, *s* secondary hydrocladium; the proximal, sarcothecal branch is a little abnormally developed]. "Ingolf" St. 44. *b* internodium of the primary tube of the stem of a young colony from "Ingolf" St. 98. *c* Hydrotheca, "Ingolf" St. 44. *d* Gonotheca in side view and front view, "Ingolf" St. 98. (*a* $\times 45$, *b*—*d* $\times 90$).

the gonotheca itself. The aperture is round or often somewhat broader, oval, and we thus find here a distinct approach to the remarkable form of gonotheca which occurs in all known forms of *Aglaophenopsis* and *Cladocarpus* species, save that a distinct upper lip is less often clearly discernible.

Nematocarpus ramuliferus was formerly only found in the cold area (fig. XXXVIII), but the two finds fall just in the zone where otherwise warmer atlantic, deeper-living visitors occur sporadi-

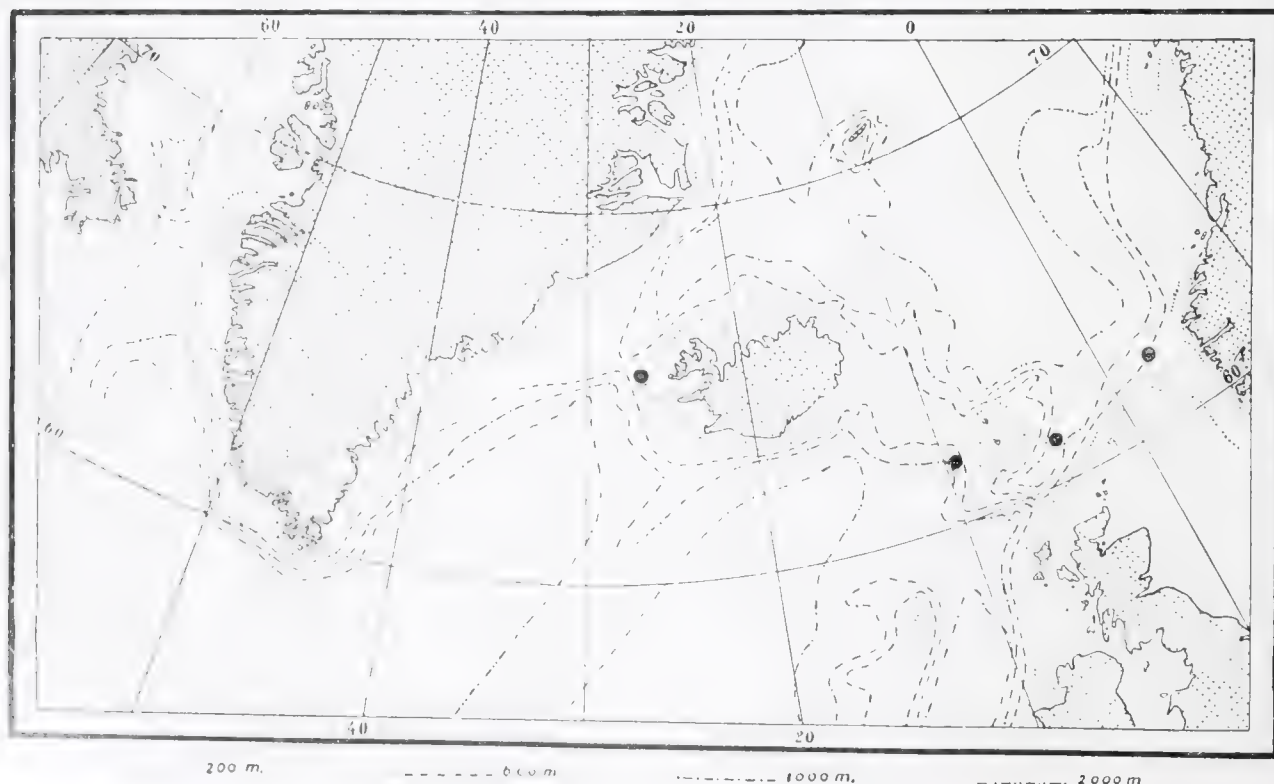


Fig. XXXVIII. Finds of *Nematocarpus ramuliferus*.

cally in the Norwegian Sea, and lie also comparatively near the submarine ridges. It was therefore most likely that the species should be reckoned, bio-geographically, as belonging to the class of such visitors, and the two new finds appear to confirm this supposition, both being situate in the warmer atlantic region; one on the slope down towards the Atlantic Deep, west of the Faroe plateau, and the other on the east side of the threshold in Danmark Strait, where several other warm-water species also come in. The last-named locality, with a depth of 138 fathoms, is the shallowest of the finds made; the others lie deeper down in the true abyssal region. We are therefore justified in concluding that the species belongs to the warmer and deeper atlantic communities.

Aglaophenopsis (Fewkes).

Upright colonies with branched or unbranched main stem, the apophyses bearing unbranched hydrocladia with several hydrothecæ. All the sarcothecæ are immobile. The gonothecæ are protected by minor branches forming a basal appendix to the hydrocladia, and with both hydrothecæ and sarcothecæ; the gonothecæ are situate on the stem or on the minor branches.

Practically speaking, this definition coincides with Nutting's limitation of the genus (1900 p. 118). Nutting also lays most stress upon the occurrence of the protective branchlets, but does not seem quite to have realised that the principal character for these lies in the fact that they bear hydrothecæ, not, as in the case of *Cladocarpus*, sarcothecæ only. *Aglaophenopsis* differs from *Nematocarpus* in principle by the fact that the minor branches do not develop into secondary hydrocladia of normal appearance, but merely appear as protective appendices in fertile colonies.

Aglaophenopsis-Cladocarpus form a pair of genera parallel with *Theccarpus-Aglaophenia*. As a matter of fact, we cannot determine which of the two in each case is the more primitive; having regard, however, to the development of a species such as *Nematocarpus ramuliferus*, which appears to be more primitive than the others in the state of its gonangia, we must probably incline to the theory that *Cladocarpus* and *Aglaophenia* are the more primitive, rather than the more highly developed. Still, we can hardly in either case regard the one genus as derived from the other; it would seem more likely that each has arisen independently.

Aglaophenopsis cornuta (Verrill) Nutting.

1879 *Cladocarpus cornutus*, Verrill, Notice on recent additions to the marine fauna, p. 310.

1900 *Aglaophenopsis cornuta*, Nutting, Plumularidæ, p. 120, pl. 30, figs. 6—9.

Colonies doubly pinnate, with branched polysiphonic main stem, monosiphonic in its extreme portions. The primary stem tube is divided into short internodia, bearing in the middle an apophyse directed obliquely forward and sideways, and three sarcothecæ, one pair nearest the upper side of the apophyse, and an unpaired one medially on the lower part of the internodium; all are split along the upper side, and project far forward, especially the paired ones. At the base of the apophyse, between it and the unpaired sarcotheca, there appears a pattern which must be interpreted as an abortive hydrotheca. The hydrocladia have on the rear side a markedly prominent keel; they are divided into short internodia, each bearing a large hydrotheca and three sarcothecæ, a supracalycine pair at the

opening, and a median proximal sarcotheca, the opening margin of which hardly reaches up to the middle of the hydrotheca; the sarcothecæ have a dentate margin, and project far forward; they are adcaulinally split. The hydrotheca is laterally compressed; seen from the side, it is egg-shaped and pointed at the lower end. The hydrotheca has abcaulinally a median keel, running out into a large, hollow, generally sharply horn-shaped tooth, the free projecting part of which may reach a length of

up to $\frac{2}{3}$ that of the hydrotheca; the cavity forms a continuation of the lumen of the hydrotheca. The hydrotheca margin has at the base of the mentioned projection a median abcauline tooth, and on either side four teeth, which become broader and less pronounced nearer the hydrocladium. The internodium has four to six inner ribs at the hydrotheca wall; an inner rib also bounds the lumen of the proximal sarcotheca on its lower end. The hydrotheca lacks inner ribs or septa.



Fig. XXXIX. *Aglaophenopsis cornuta*. "Ingolf" St. 25. — *a*. Cauline internodium of the primary tube, showing both sarcothecæ of the upper pair. — *b*. Front view of the internode, showing the abortive hydrotheca at the base of the apophyse above the proximal sarcotheca. ($\times 40$).

The gonothecæ are set on the stem, or more often on short, once dichotomically divided branchlets proceeding from the basal internodium of the hydrocladium beside its proximal sarcotheca; the small branches bear as a rule a hydrotheca on each branchlet; more rarely the one may have two hydrothecæ, the other one. The gono-

theca is broad oval to pear-shaped; seen from the side it is somewhat more slender, with subterminal opening on the adcladial side and with a short upper lip, formed by the abcladial wall, which is domed forward roofwise over the opening.

Material:

"Ingolf" St. 15, 66°18' N., 25°59' W., depth 330 fathoms $\div 0.75^{\circ}$

— - 25, 63°30' N., 54°25' W., — 582 — 3.3°

- 98, 65°38' N., 26°27' W., — 138 — 5.9°

Greenland: Davis Strait, — 100 — (without further details)

65°30' N., 55°36' W., — 289 —

In Nutting's description of *Aglaophenopsis cornuta* (1900 p. 120) there is a misunderstanding as to the cauline sarcothecæ, which he describes as follows: "cauline nematophores very large, one just at the base of each hydrocladium, another immediately below this, and a third, long and spur-like opposite the base of each hydrocladium". As regards the last sarcotheca (fig. XXXIX *a*) this is as a matter of fact one of a pair situate nearer the upper side of the base of the apophyse; both of them project far out from the stem, but on viewing the colony from the front (fig. XXXIX *b*) the one is hidden by the basal part of the hydrocladium. The lower, proximal sarcotheca is very broad, and does not project quite as much. The sarcotheca which Nutting mentions as just at the base of the hydrocladium, i. e. practically on the apophyse itself, must on the other hand be regarded as an abortive hydrotheca which has been checked in its development by the growth of the apophyse and hydrocladium; it bears no resemblance to the remaining sarcothecæ, and does not seem to be provided with any sarcostyle or nematophore. A point of great importance in this explanation is also the fact that the basal portion of large pinnate parts may be formed of internodia with hydrothecæ, but without

apophyses and hydrocladia; here again we find the supracalycine sarcothecæ particularly well developed, in the same manner as over the apophyse, and more than on the normal cladial internodia; at the same time there is not the slightest indication of any such pattern as that which Nutting has taken for a sarcotheca. The abortive hydrotheca probably forms a parallel to the apophysal "mamelon" in *Nemertesia* and *Polynemertesia*, and would seem to throw some light on its origin.

There is considerable variation in the appearance of the hydrothecæ (fig. XL) especially owing to the fact that the abcauline keel and its prolongation vary very greatly both in length and breadth; the outgrowth may be broad and blunt, or more slender, and running out to a point. It forms an incurvation in the wall of the hydrotheca; at its base, the hydrotheca is furnished with a sharply cut tooth, directed obliquely inward and forward, and between this and the internodium the edge shows

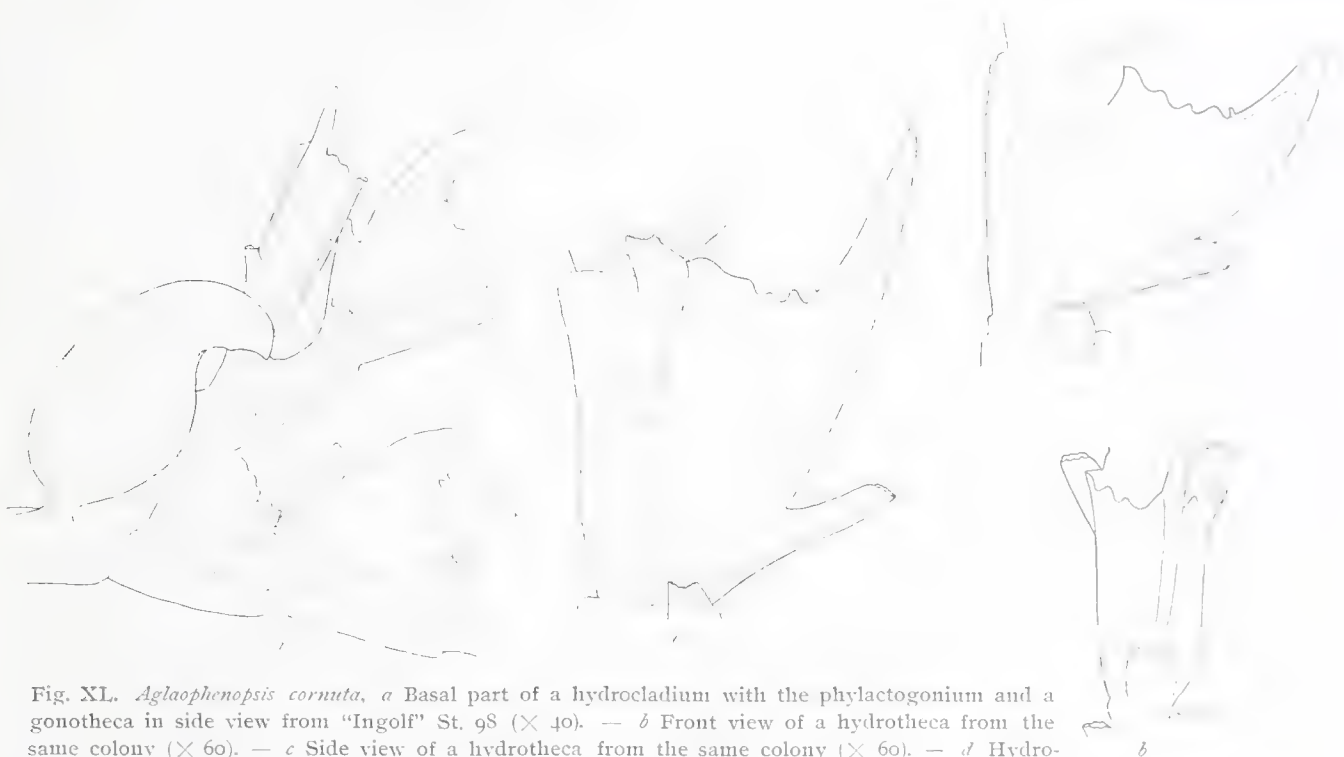


Fig. XL. *Aglaophenopsis cornuta*, *a* Basal part of a hydrocladium with the phylactogonium and a gonotheca in side view from "Ingolf" St. 98 ($\times 40$). — *b* Front view of a hydrotheca from the same colony ($\times 60$). — *c* Side view of a hydrotheca from the same colony ($\times 60$). — *d* Hydrotheca from a colony from "Ingolf" St. 25, side view ($\times 60$).

as a rule four teeth on either side, which become broader and lower nearer the hydrocladium. The innermost tooth on either side, and at times the one next to it, can even now and again be entirely effaced, so that only two abcauline teeth can be distinguished on either side. — The proximal sarcotheca also varies considerably, diverging now more, now less widely from the hydrotheca, and having a free portion of varying length.

The basal internodium of the hydrocladium has a different structure owing to the position of its proximal sarcotheca. This is shifted to the obliquely upward trending hydrocladium, — the side away from the stem — and is also somewhat smaller than on the following internodia. The cause of this must be sought in the growth of the phylactogonium.

The phylactogonium (fig. XL *a*) is segmented and has only hydrothecæ on two of its branches; on one of them at times two, but as a rule only one on each; they are surrounded by the usual three

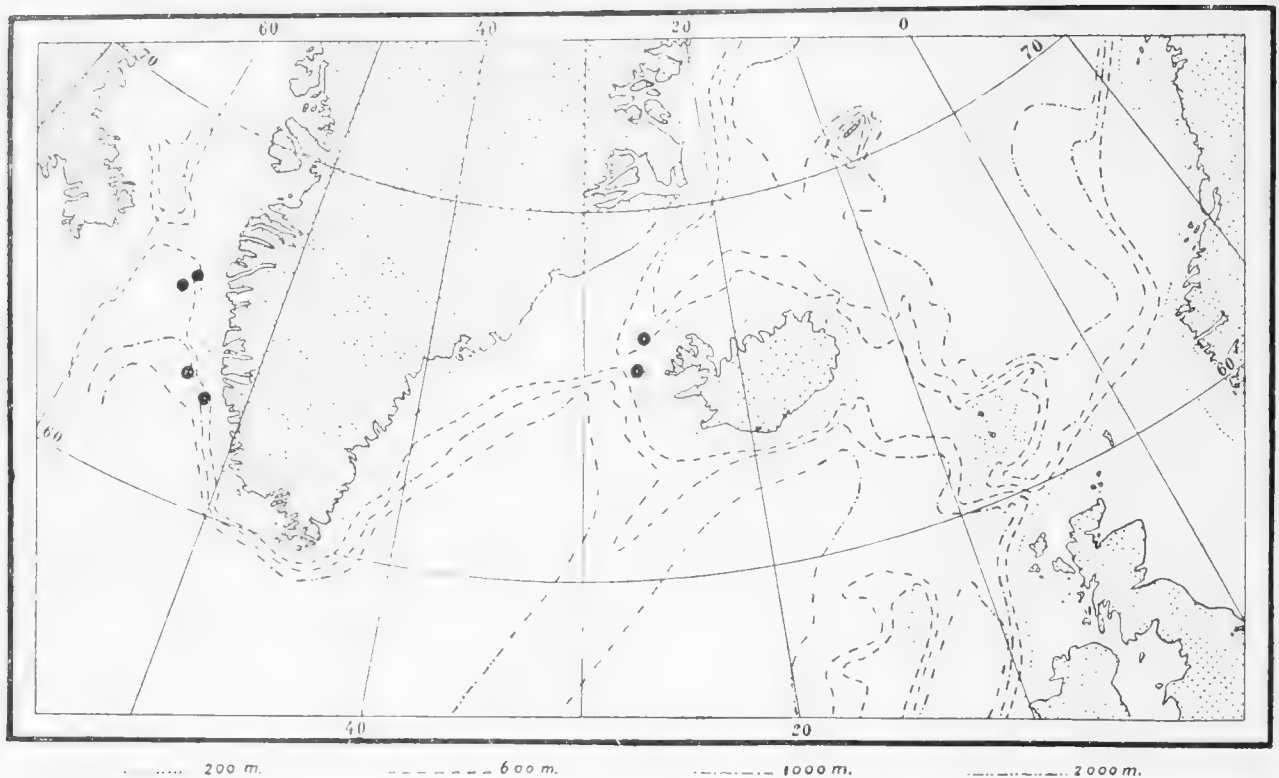


Fig. XLI. Finds of *Aglaophenopsis cornuta* in the Northern Atlantic.

sarcothecæ, which, however, are here generally somewhat smaller than on the hydrocladia. The gonotheca has a well developed upper lip, which does not appear clearly from Nutting's illustration and description. It is domed strongly forward, so that the aperture becomes turned down towards the base.

Aglaophenopsis cornuta is a typical deep-sea species which has only in Davis Strait been observed at 100, and in Danmark Strait at 138 fathoms depth; it can thus also penetrate up into the lower part of the littoral region. The species probably belongs strictly speaking to the warm, deep northern part of the Atlantic; it moves up into Davis Strait, where it appears to be of not infrequent occurrence (fig. XLI) and has now, as we see, also been recorded from Danmark Strait. As it is not known from other localities than those mentioned and the waters off Nova Scotia, we are justified in characterising it for the present as a west atlantic species.

Aglaophenopsis (?) *pharetra* n. sp.

The colony pinnate with polysiphonic stem, monosiphonic in the extreme portions, and having the primary tube indistinctly segmented. Each of the internodia of the stem bears at two thirds of its height a well defined, fairly short apophyse, and three unpaired sarcothecæ, two in the median line below the apophyse, and the third in the corner between the stem and the apophyse above the origin of the latter. The alternately placed hydrocladia form almost a right angle with the stem; they are divided into long internodia, each of which bears a hydrotheca, and three sarcothecæ, a supracalycine pair at the opening of the hydrotheca and an unpaired proximal about midway between the base of the hydrotheca and the proximal end of the internodium; the opening margin of the

proximal sarcotheca does not reach up to the base of the hydrotheca; all the sarcothecæ have a smooth margin and are adcaulinally split. The length of the hydrotheca is about three-fifths that of the internodium. The hydrotheca is of extremely slender build, not laterally compressed, somewhat expanded towards the opening; the opening margin is quite smooth. Numerous small inner ribs are found in the internodia along the hydrotheca wall; a rib also forms the lower boundary of the proximal sarcotheca.

Material:

"Ingolf" St. 81 61°44' N., 27°00' W., depth 485 fathoms, 6,1°.

Of this remarkable species we have only a single quite small colony, the height of which amounts to only about 2 cm. above the close rootlike network by which it was attached. The upper 6 mm. bear the hydrocladia, two fairly long on each side, and there is also, at the top of the colony on the left side, a third hydrocladium where the hydrotheca no 2 is still only indicated. On the lower part of the stem there is a secondary tube, which creeps upward along the lower 7 mm. of the primary, showing that the fully grown colony will exhibit a polysiphonic stem. The primary tube differs from that of most other species in the arrangement of the sarcothecæ (fig. XLII *a*); paired cauline sarcothecæ are lacking, but each internodium has three unpaired sarcothecæ; the two lower in the median line one above the other, and the third in the corner at the upper side of the apophyse.

The hydrothecæ are very characteristic (fig. XLII *b, c*), in appearance not unlike a slender quiver, whence the species has been named *pharetra*. The opening margin is quite smooth, without indication of teeth or irregularities. The supracalcine sarcothecæ project somewhat up beyond the hydrotheca opening. The proximal sarcotheca is separated by a quite considerable interval from the hydrotheca.

As no indications of gonangia have yet been found, the systematic position of the species cannot yet be determined with certainty. It presents, however, a so considerable resemblance to *Aglaophenopsis Verrilli* Nutting that it should, for the present at any rate, be placed near this; the differences consist in the somewhat shorter and broader hydrothecæ of the latter species, where the opening is furnished with teeth, as also in the much shorter distance from the hydrotheca to the proximal sarcotheca. The species is therefore placed with a query in the same genus, under the name of *Aglaophenopsis (?) pharetra*. On the other hand, it also resembles not a little certain *Cladocarpus*

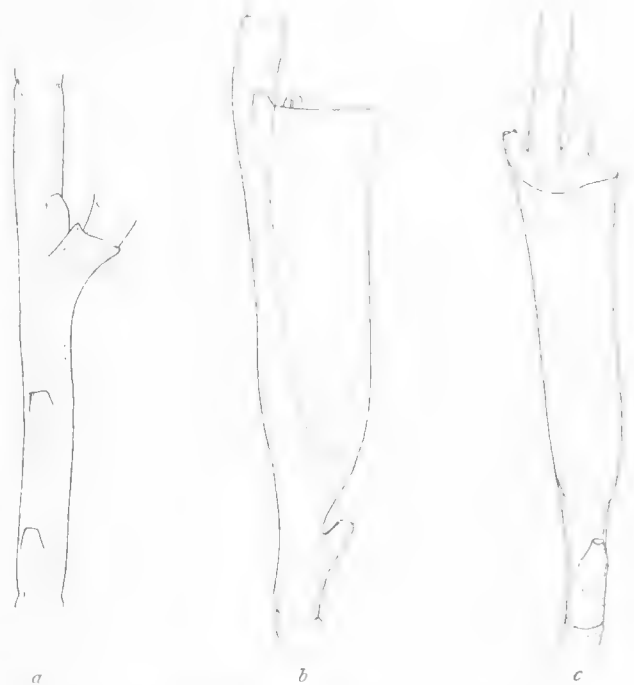


Fig. XLII. *Aglaophenopsis (?) pharetra* from "Ingolf" St. 81. *a*. Internodium of the primary cauline tube with the apophyse. *b*. Internodium of the hydrocladium with hydrotheca in side view. *c*. Frontal view of hydrotheca and internodium. ($\times 60$).

species such as *Cladocarpus tenuis* Clarke and *Cladocarpus flexuosus* Nutting. There is therefore the possibility that the species may have to be referred to this genus, and the query affixed to the generic name must remain for the present.

Only the one specimen was found, in the deep south west of Iceland. The locality suggests that we have here to deal with a warm-water form from the deep water of the Atlantic.

Cladocarpus Allman

Upright colonies with branched or unbranched main stem, the apophyses with unbranched hydrocladia with several hydrothecæ. All the sarcothecæ are immobile. The gonothecæ are protected by small branches, phylactogonia, which form a basal appendix to the hydrocladia, and are furnished with sarcothecæ, but lack hydrothecæ. The gonothecæ are set on the stem or on the phylactogonia.

Cladocarpus integer (G. O. Sars).

1874 *Aglaophenia integra*, G. O. Sars, Bidrag til Kundskaben om Norges Hydroider, p. 100, pl. 2, figs 11—15.

1879 *Cladocarpus Pourtalesi*, Verrill, Notice on recent additions to the marine fauna, p. 309.

1893 *Cladocarpus Holmi*, Levinsen, Meduser, Ctenophorer og Hydroider, p. 67, tab. VIII, figs. 15—18.

The colonies are doubly pinnate with branched polysiphonic main stem, exhibiting only in its very outermost parts the primary segmented tube alone; this has fairly short internodia, bearing on the basal third a strong but short apophyse; the internodium is also furnished with three adcaulinally split sarcothecæ, an unpaired median at the bottom, and a pair at the upper side of the apophyse. The internodium of the hydrocladium has a fairly large hydrotheca and three sarcothecæ, a supracalyceine pair at the opening, and a median proximal sarcotheca, which with its opening margin hardly reaches up to the basal fourth of the hydrotheca; all the sarcothecæ approach the tubulous form, but are adcladially split. The hydrothecæ are laterally somewhat compressed, and slightly expanded at the opening; the opening margin, in the hydrothecæ as in the sarcothecæ, is quite smooth. The internodium exhibits one or two inner ribs at the hydrotheca wall, and two below the proximal sarcotheca.

The gonothecæ are fastened as a rule by a rudimentary stalk to the stem or to the phylactogonia, which are almost invariably unbranched, and have two irregular rows of sarcothecæ; the phylactogonium proceeds from the basal internodium of the hydrocladium, beside the proximal sarcotheca. The gonotheca is somewhat flattened; seen from the flat side it is broadly pear-shaped, broadly rounded distally; viewed laterally, it is a slender oval, with a distal lateral adcauline opening over which the abcauline wall domes out like an upper lip.

Material:

"Ingolf" St.	25	63°30' N.,	54°25' W.,	depth 582 fathoms,	3,3°
—	- 27	64°54' N.,	55°10' W.,	— 393 —	3,8°
	- 94	64°56' N.,	36°19' W.,	— 204 —	4,1°
	- 98	65°38' N.,	26°27' W.,	— 138 —	5,9°

Greenland: Davis Strait, depth 80 fathoms (without further details) [type specimen of *Cladocarpus Holmi*]

Iceland: 5 miles E. of Seydisfjord, depth 135 fathoms [labelled *Cladocarpus Holmi*].

Cladocarpus integer has led a somewhat unsettled existence in various genera. G. O. Sars (1874 p. 100) regarded it as an *Aglaophenia*, and is followed by Bonnevie (1899 p. 93) who places all northern *Aglaopheniidae* in this one genus. Jäderholm (1909 p. 109 and 110) refers to it either as *Halicornaria integra* or as *Cladocarpus Holmi* and *Cladocarpus Pourtalesi*, while Ritchie (1912 p. 228) classes the species under *Halicornaria*. A very rich material from the Trondhjem Fjord, where the species is found in great numbers, enabled me to study it further, and determine its systematic position. And it now turns out that the species must be regarded as a primitive *Cladocarpus*. The

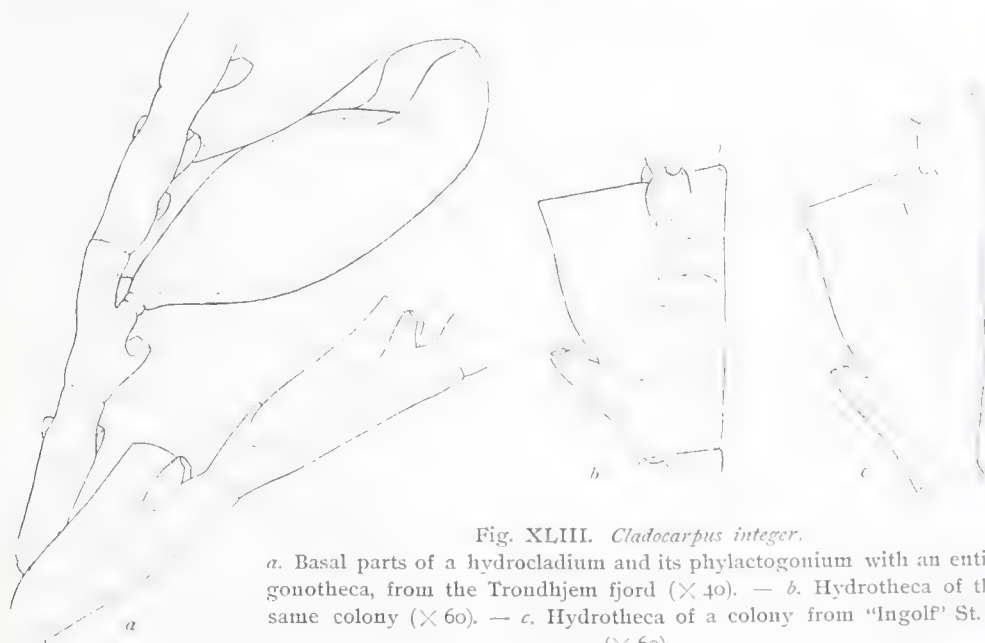


Fig. XLIII. *Cladocarpus integer*.

a. Basal parts of a hydrocladium and its phylactogonium with an entire gonotheca, from the Trondhjem fjord ($\times 40$). — *b.* Hydrotheca of the same colony ($\times 60$). — *c.* Hydrotheca of a colony from "Ingolf" St. 98 ($\times 60$).

gonothecæ are very often fixed to the stem or more correctly, to the apophyses; Ritchie's descriptions show that this may often occur on the whole for an entire colony, and that the phylactogonia may in consequence be altogether lacking, which is also exceptionally found to be the case in some of the colonies from Trondhjem Fjord. The great majority of the colonies have, however, at any rate in considerable parts of each, developed primitive but typical phylactogonia (fig. XLIII *a*). These proceed from the basal internodium of the hydrocladium beside the proximal sarcotheca. The phylactogonia are practically always unbranched, and furnished with two somewhat onesidedly arranged rows of sarcothecæ, set either in pairs or irregularly placed; only once or twice have I found phylactogonia which had, by dichotomic division, developed a short lateral branch of the same structure. The phylactogonium also exhibits irregular segmentation. It has as a rule two or three gonothecæ on the same side as the sarcothecæ. The gonotheca is of the typical *Cladocarpus* form, with upper lip; this is, however, shorter than in most other species, so the opening is not yet directed downwards.

Ritchie's specimen (1912 p. 228) should, it would seem, be taken as the representative of a special variety *Ritchiei* nov. differing from the typical form in having the hydrotheca margin slightly

sinuous. The internodal ribs of this variety are also somewhat more strongly marked than in the common form, and it likewise shows a more pronounced indication of intrathecal septum.

The features mentioned, that the species can at times lack phylactogonia, show that *Cladocarpus Pourtalesi* must be considered as a synonym. The difference between this species and *Cladocarpus Holmi* is not apparent from Levinson's description of the latter (1893 p. 67) and an investigation of the type specimens shows that the species has been founded on typical colonies of *Cladocarpus integer*.

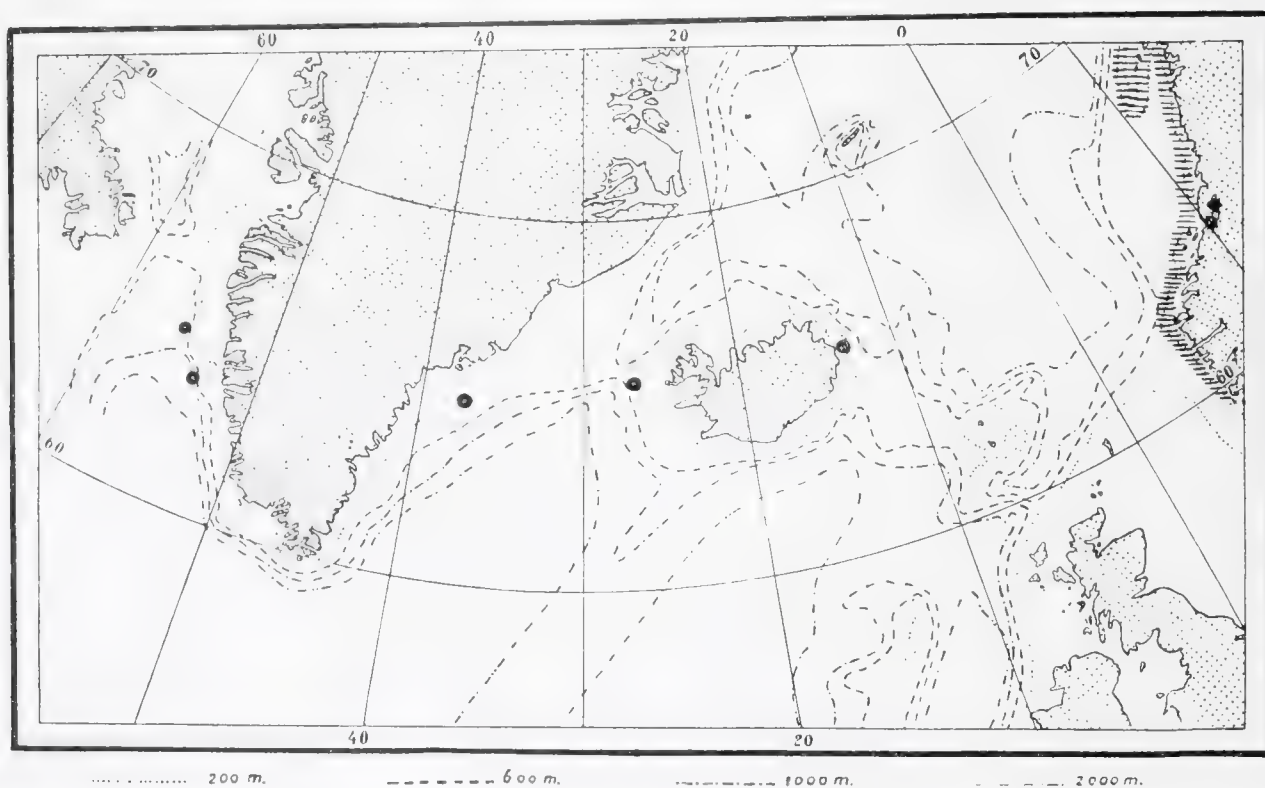


Fig. XLIV. The distribution of *Cladocarpus integer* in the northern Atlantic.
In the hatched regions the literature denotes a scattered occurrence.

The species is a typical warm atlantic form, which appears to have its chief occurrence in the western Atlantic, in the lower part of the littoral region and the upper part of the abyssal. In northern waters, it has long been known from the west coast of Norway, and is also found to be a not altogether infrequent visitor to Greenland, both in Davis Strait and up towards Danmark Strait (fig. XLIV). On one occasion, it was met with off the east coast of Iceland, at the boundary of the arctic deep region. That it has not yet been located with certainty between the British Isles and Iceland must be due to accident. Ritchie (1912 p. 228) had before him a specimen brought home by Hull trawlers, and we may doubtless presume that it would then have originated from the northern slope of the North Sea plateau or from the Faroe Islands Banks.

Cladocarpus formosus Allman.

1874 *Cladocarpus formosus*, Allman, Report on the Hydroida Porcupine, p. 478, pl. 68, fig. 1.

1893 *Cladocarpus crenulatus*, Levinsen, Meduser, Ctenophorer og Hydroider, p. 68, pl. VIII, figs. 13—14.

The colonies have an unbranched or branched polysiphonic stem. The primary, foremost tube is divided into short internodia with a short apophyse directed obliquely forward and sideways, and three sarcothecæ, a pair at the upper side of the apophyse, and an unpaired median on the basal part of the internodium, all adcladially split. The internodia of the hydrocladium are short, and bear a large broad hydrotheca and three sarcothecæ, a supracalyceine pair at the hydrothecal aperture, and

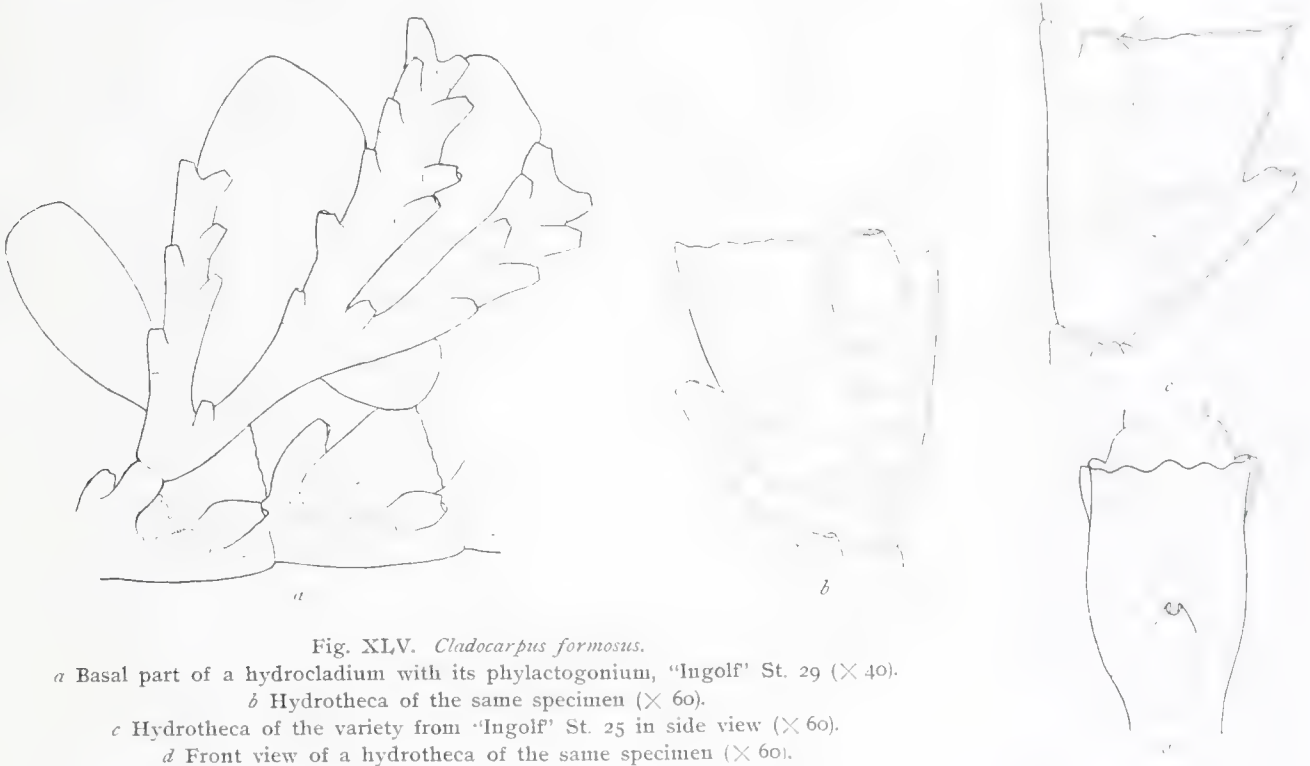


Fig. XLV. *Cladocarpus formosus*.

a Basal part of a hydrocladium with its phylactogonium, "Ingolf" St. 29 (X 40).

b Hydrotheca of the same specimen (X 60).

c Hydrotheca of the variety from "Ingolf" St. 25 in side view (X 60).

d Front view of a hydrotheca of the same specimen (X 60).

a median proximal, which reaches with its opening margin nearly up to the middle of the hydrotheca; the sarcothecæ have a slightly dentate margin, and are adcaulinally split. On the basal internodium of the hydrocladium, the proximal sarcotheca is divided off by an interval from the hydrotheca. The hydrothecæ are large, and nearly circular in transverse section, with an abcladial intrathecal septum; the opening margin is slightly sinuous, with more prominent teeth abcladially, and with a quite distinct abcladial median tooth.

The gonothecæ are situate on the stem or on the phylactogonia, which proceed from the basal internodium of the hydrocladium, at the interval between the hydrotheca and the proximal sarcotheca. The phylactogonia have, after two dichotomic divisions, three branches, and bear on their outer side two rows of paired or irregularly placed sarcothecæ. The gonothecæ are somewhat flattened, pear-shaped from the broad side, with transversely rounded distal part; seen from the side, with a terminal lateral opening over which one wall domes out in a markedly prominent upper lip.

Material:

"Ingolf" St.	25	63°30' N.,	54°25' W.,	depth 582 fathoms	3,3°
—	- 29	65°34' N.,	54°31' W.,	— 68 —	0,2°
—	- 34	65 17' N.,	54°17' W.,	— 55 —	
—	- 93	64°24' N.,	35°14' W.,	— 767 —	1,46°
—	- 97	65°28' N.,	27 39' W.,	— 450 —	5,5°
—	- 127	66°33' N.,	20°05' W.,	— 44 —	5,6°

Greenland: Davis Strait, depth 80 fathoms (without further details) [type specimen of *Cladocarpus crenulatus*]

65°39' N., 28°25' W., depth 553 fathoms [type specimen of *Cladocarpus crenulatus*].

Cladocarpus formosus is described in detail by Ritchie (1909) from some colonies taken at about the same place as Allman's type specimens. Among the features which he here notes is the fact that the opening margin of the sarcothecæ is "serrate". Most of the present colonies fully agree with Ritchie's careful description. We have, however, from the "Ingolf" St. 25, in addition to many typical colonies, also some few of slightly different structure (fig. XLV). The hydrothecæ are here somewhat broader than the normal, the septum is set a little deeper down, and goes considerably farther in towards the adcladial side than in ordinary colonies of the species, while on the other hand the internodial ribs are less pronounced, and fewer in number. Furthermore, all the sarcothecæ here have smooth opening margin. The points of difference, as compared with the typical form of *Cladocarpus formosus*, are thus sufficiently marked; they are however, too slight to warrant our marking off a distinct species, since no other differences can be discerned. The colonies should thus merely be regarded as representatives of a special variety within the species.

Ritchie (1909 p. 314) points out that Levinsen's *Cladocarpus crenulatus* (1893 p. 68) must be regarded as a synonym of *Cladocarpus formosus*; and after having examined Levinsen's type specimens, I must entirely concur in this view. Bonnevie (1899 p. 95) mentions *Aglaophenia formosa* from a station near Spitzbergen; her description however, differs not a little from Allman's, and from those of later writers; in the first place, no mention is made of the intrathecal septum, in addition to which, the description of the hydrotheca as "almost cylindrical, regularly dentated round the margin" is hardly in accordance with what we otherwise know of the species; the published drawings (1898 Taf. 2, fig. 3) also differ somewhat, so that the identity of the colony seems doubtful. An investigation of the type specimen, however, shows that the intrathecal septum is present, and that the specimen only differs from the colonies here in question in the somewhat more distinct and regular dentition of the hydrotheca margin. In addition, one of the phylactogonia is pinnately branched, as in *Cladocarpus paradiscus* Allman, while the others are dichotomically branched.

Cladocarpus formosus is plainly one of the most common forms in the warmer tracts belonging to the upper part of the abyssal region in the North Atlantic (fig. XLVI) and penetrates thence up into the lower part of the littoral region. It is originally known from the southernmost part of the cold area, where the latter runs into the Faroe Channel, but should here be regarded as a visitor, brought in by larval transport with the Atlantic current. The species is previously known from

Davis Strait, from where the "Ingolf" brought back several colonies, and has now also been found in deeper water right up in the Danmark Strait. From here again, it may be transported into the waters along the north coast of Iceland, as shown by the find at the "Ingolf" St. 127, where the species occurs together with *Halicornaria campanulata*.

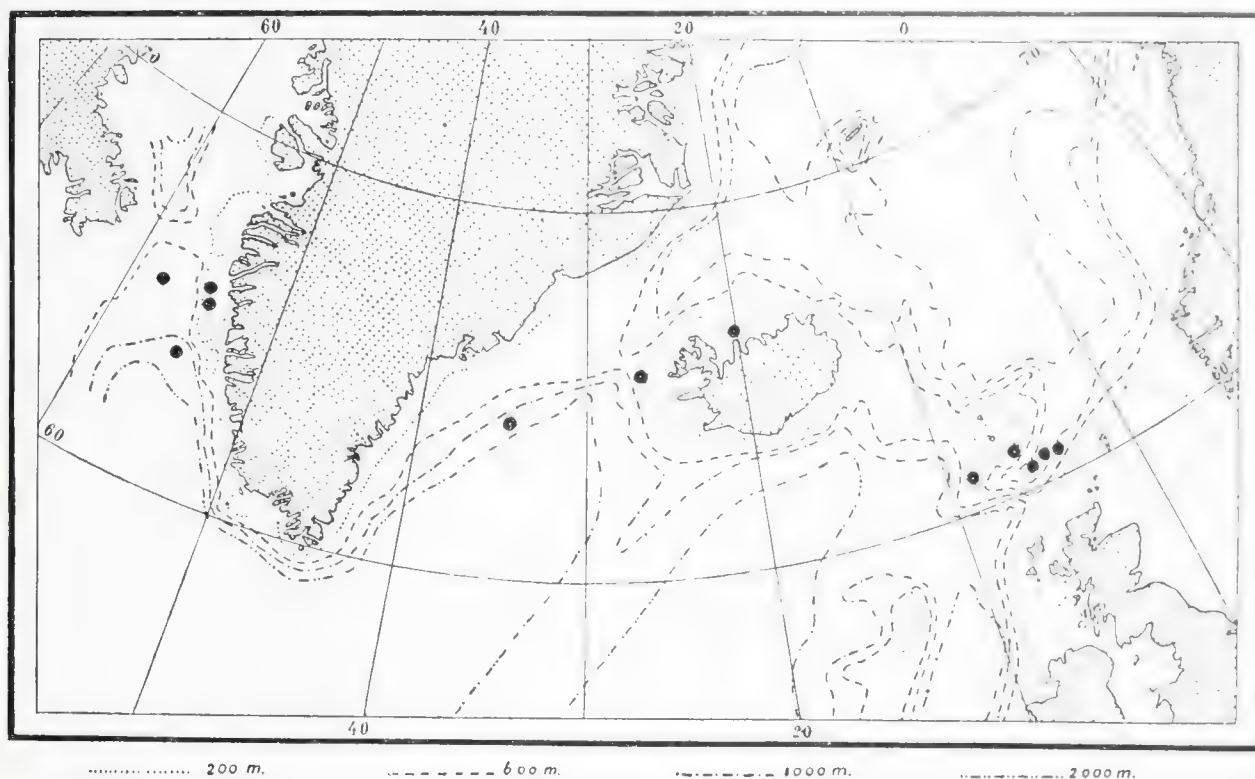


Fig. XLVI. Finds of *Cladocarpus formosus* in the Northern Atlantic.

Cladocarpus Diana nov. sp.

The colonies are singly pinnate with polysiphonic, in the upper parts monosiphonic main stem, which is not particularly strongly pronounced. The primary tube is indistinctly segmented, with long internodia, each having on its upper third an apophyse turned almost straight out to the side, alternately directed to either side of the stem. The internodium further has three or four sarcothecæ, a pair at the upper side of the apophyse, and one or two unpaired in the median line on the lower part of the internodium; all are adcaulinally split. The internodia of the hydrocladium have a large hydrotheca and three sarcothecæ, a supracalycine pair at the hydrotheca aperture, and an unpaired median proximal sarcotheca which reaches with its opening margin barely a little beyond the bottom of the hydrotheca. The supracalycine sarcothecæ approach the tubulous form, but are adcladially split; the proximal is of very typical shape, being much widened out laterally towards the opening, so that the latter is seen to be as broad as, or even slightly broader than, the lower part of the hydrotheca; the free adthecal wall has disappeared; the margin is slightly dentate. The hydrothecæ are large, somewhat compressed laterally, with expanded opening part; the margin of the aperture is armed with 9 strong teeth, an abcladial median, and between this and the internodium four on either side. There

is an indication of four to five faint inner ribs in the internodium at the hydrotheca; the proximal sarcotheca is bounded on the lower side by a strong rib.

The gonothecæ are situated on dichotomically branched phylactogonia proceeding from the basal internodium of the hydrocladia beside its proximal sarcotheca. The phylactogonia have three branches, which bear, on the side turned towards the stem, a row of sarcothecæ, and can be indistinctly segmented. The gonotheca is somewhat flattened; seen from the broader side it is a broad oval, or egg-shaped, fastened by the pointed end to the phylactogonium. The opening is broad, subterminal, and turned downwards owing to the fact that the abcladial side curves far out beyond the opening as a broad upper lip.



Fig. XLVII. *Cladocarpus Diana*. "Ingolf" St. 78. — *a* Phylactogonium with gonotheca ($\times 40$).
— *b* Hydrotheca in side view ($\times 60$). — *c* Hydrotheca in front view ($\times 60$).

Material:

"Ingolf" St. 46, $61^{\circ}32'$ N., $11^{\circ}36'$ W., depth 720 fathoms 2.4°
— - 78, $60^{\circ}37'$ N., $27^{\circ}52'$ W., — 799 — 4.5°

Cladocarpus Diana has much stronger hydrothecal teeth (fig. XLVII) than most other species of the genus; nearest in this respect is *Cladocarpus compressus* Fewkes, but the teeth there are somewhat broader; in addition, the intervals between the teeth in *Cladocarpus Diana* are curved somewhat outwards. The most remarkable character, however, lies in the proximal sarcotheca. Seen from the side, this does not differ greatly from other previously known species, being only unusually short, so that the opening margin does not extend much beyond the bottom of the hydrotheca. But on examining the sarcotheca from the ventral side (fig. XLVII *c*) we find that it has its greatest breadth at the opening margin, which may even be slightly longer than the breadth of the lower and middle part of the hydrotheca. The sarcotheca has only one opening, which is correspondingly larger, the free wall turning towards the hydrotheca being entirely effaced.

Cladocarpus Diana exhibits also certain peculiarities in the gonosome (fig. XLVII *a*). The phylactogonium divides dichotomically a little above the base, and the outer branch, that farthest from the median line of the colony, soon divides again dichotomically into two, giving a slightly upward curving phylactogonium with three short branches. These have only a single open row of strong sarcothecæ on the side turned towards the median plane of the colony; each branch has from three to five sarcothecæ. The branches of the phylactogonium are richly furnished with inner ribs, and are also often irregularly segmented. The phylactogonia bear two or three gonothecæ of the same type as that usual in the genus, with a strongly developed upper lip domed out roofwise over the broad opening, which is turned towards the phylactogonium.

The colony from the "Ingolf" St. 46 exhibits the peculiarity of having the outer branch of the seventh phylactogonium from below on the left side prolonged; at the terminal point of the normal branch arises a further lateral branch; the outer branch is further prolonged, and has, outside the above-mentioned supernumerary branch, three hydrothecæ, and thus from here presents the appearance of a hydrocladium, which in addition to its basal hydrotheca further shows the incipient development of a secondary phylactogonium. The entire formation must be regarded as an abnormality.

***Cladocarpus bicuspis* (G. O. Sars) Jäderholm.**

1874 *Aglaophenia bicuspis*, G. O. Sars, Bidrag til Kundskaben om Norges Hydroider, p. 98, pl. 2, figs. 7—10.
1909 *Cladocarpus bicuspis*, Jäderholm, Northern and Arctic Invertebrates, p. 110.

The colony is pinnate with polysiphonic, in the outer portions monosiphonic main stem. The primary tube is divided into short internodia, each bearing an apophyse directed obliquely forward and sideways, turned alternately to either side of the median line. The internodium is further provided with three sarcothecæ, a pair at the upper side of the apophyse, and an unpaired one in the median line of the internodium, close below the apophyse; all are adcaulinally split. The internodia of the hydrocladium have a very large hydrotheca and three sarcothecæ, a supracalycine pair at the hydrotheca aperture and an unpaired median proximal reaching up to the lower third of the hydrotheca; all sarcothecæ are adcladially split, and have quite smooth margins. The hydrothecæ are laterally much compressed, with outward curving opening margin, and with an abcauline pair of large teeth; the margin otherwise smooth; the sinus between the teeth is almost square. The teeth are concave, the incurvation strongest at the median line. From the sinus between the teeth an inner rib runs along the abcladial side of the hydrotheca to its middle, where it terminates in a strong S-shaped intrathecal septum, dividing the hydrotheca into a larger upper portion and smaller basal part, the latter half the size of the former. The internodium is furnished at the hydrotheca wall with four or five short ribs, the proximal sarcotheca is bounded on the lower side by an oblique septum.

The gonothecæ are situate on the stem or on short, dichotomically three- to four-branched phylactogonia, proceeding from the basal internodium of the hydrocladium beside its proximal sarcotheca. The phylactogonia are furnished with sarcothecæ irregularly arranged, and not infrequently having indistinct segmentation. The gonotheca is somewhat flattened; from the broad side it is reversely

conical, broadly rounded distally, with a broad opening towards the phylactogonium; in lateral view, the abcladial wall is seen to dome out in a large upper lip over the opening, which is consequently turned downwards towards the base.

Material:

"Ingolf" St. 51 64°15' N., 14°22' W., depth 68 fathoms 7,32°
 — - 98 65°38' N., 26°27' W., — 138 — 59°

Of this highly peculiar species, a couple of well developed colonies have been found; it resembles somewhat *Cladocarpus paradiscus* Allman, with its two strong abcladial teeth, but these are



Fig. XLVIII. *Cladocarpus bicuspis* from "Ingolf" St. 98.
 a Basal part of a hydrocladium with its phylactogonium ($\times 40$).
 b Side view of a hydrotheca ($\times 60$). — c Front view of a hydrotheca ($\times 60$).

more strongly developed in *Cladocarpus bicuspis* (fig. XLVIII) than in the species mentioned, and their appearance is the more striking from their marked incurvation, which renders the median sinus more prominent. The strong S-shaped septum is suggestive of *Cladocarpus sigma* Allmann; on the other hand, the inner longitudinal abcladial keel seems to be without parallel in the genus.

The phylactogonia are dichotomically branched, the ramification does not always take place once only, as in the one shown (fig. XLVIII a), but as a rule two or three times, so that we have three or four terminal branches. The gonothecæ shown by G. O. Sars (1874 pl. 2, fig. 8) are not yet fully grown. The full-grown gonotheca presents the same typical appearance as the remaining northern *Cladocarpus* species, with a much more strongly developed upper lip domed out over the opening; it is here as strongly developed as in *Cladocarpus Diana*.

Cladocarpus bicuspis is altogether a rare species in the regions investigated (fig. XLIX) and as it does not seem to have been found at all elsewhere, its true habitat is still a matter of doubt. In the northern waters, the species belongs to the typical visitors from the warmer atlantic waters, being previously known only from between Stavanger and Trondhjem Fjord on the west coast of

Norway; now the "Ingolf" has added two new localities, the one being off the south-east point of Iceland, the other in the eastern part of Danmark Strait, at a spot where several representatives of the heat-loving deep-water fauna of the Atlantic have been found. The bathymetrical position of the species is also somewhat doubtful: up to the present it has only been found in the middle and lower parts of the littoral region.

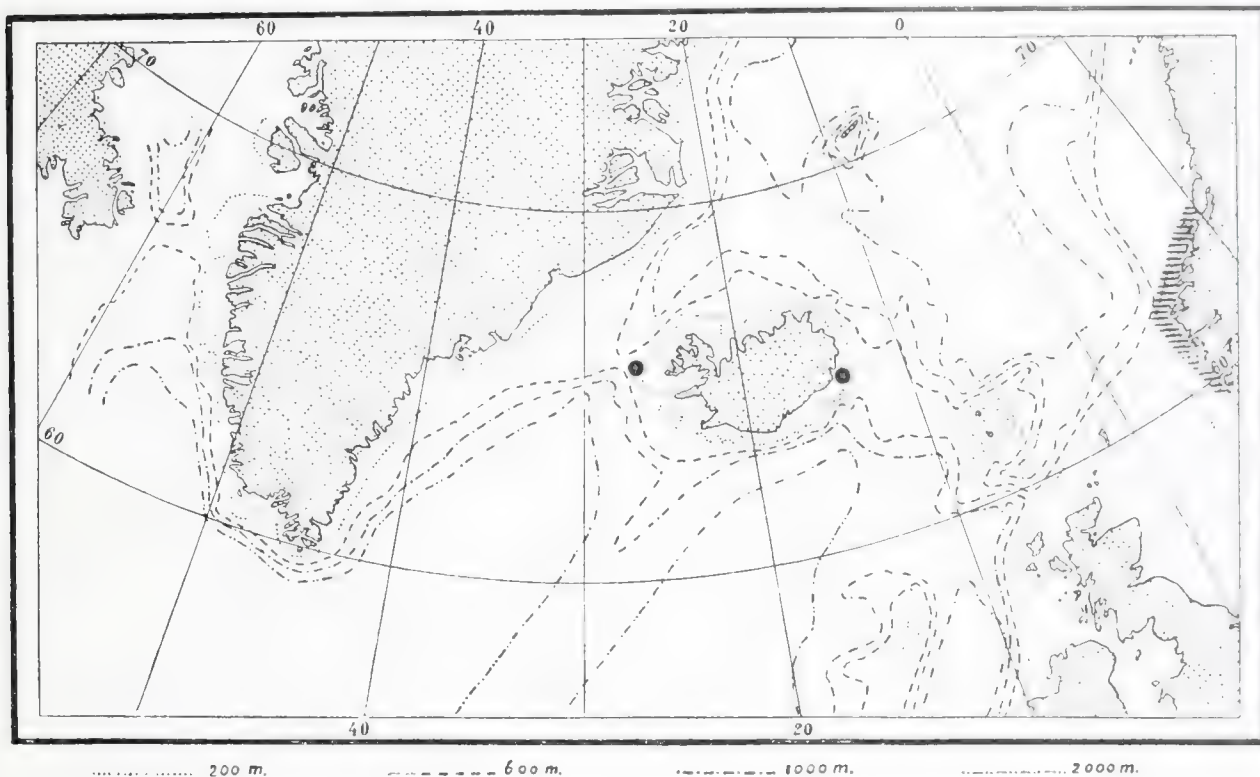


Fig. XLIX. The occurrence of *Cladocarpus bicuspis* in the Northern Atlantic.
In the hatched region the literature notes a scattered occurrence.

Gen. *Thecocarpus* Nutting.

Upright colonies with branched or unbranched main stem, the apophyses bearing unbranched hydrocladia with several hydrothecæ. All sarcothecæ immobile. The gonothecæ are set in a corbula formed by a metamorphosed hydrocladium; the blades of the corbula, or ribs, have each a hydrotheca near its point of origin.

Nutting (1900 p. 106) attaches primary importance to the question whether the stem is monosiphonic, a character which, even in distinction of species, is of subordinate weight; a species such as *Thecocarpus myriophyllum* (Linné) occurs in northern seas not infrequently fertile with monosiphonic stem, while other colonies have a polysiphonic basal part; but it is really only in southern waters that strong colonies of this species are found with polysiphonic stems, at any rate a couple of feet high. This feature, then, is of little or no interest from the point of view of generic distinction; on

the other hand, it is perfectly correct to take the furnishment of the corbula blades with hydrothecæ as of primary importance, which Billard (1913 p. 85) also points out. The breadth of the single corbula blade however, is of minor significance in this respect, and cannot be taken as proof that the corbula here is more primitive than in *Aglaophenia*, where narrow-bladed corbulæ have also been found.

Thecocarpus myriophyllum (Linné) Nutting.

1758 *Sertularia myriophyllum*, Linné, *Systema naturæ*, ed. 10, p. 810.

1900 *Thecocarpus myriophyllum*, Nutting, *Plumularidæ*, p. 107, pl. 24, figs. 12—13.

The colonies have an unbranched or branched, polysiphonic or monosiphonic main stem. The primary tube of the stem is divided into shorter or longer internodia, each bearing about the middle a short apophyse, directed obliquely forward and sideways; at the base of this at its upper side there is a pair of sarcothecæ, and on the basal part of the internodium an unpaired median sarcotheca. The short internodia of the hydrocladium have each a large hydrotheca, slightly compressed laterally, and three sarcothecæ, a supra-calycine pair at the hydrotheca opening and a short proximal unpaired sarcotheca, the opening margin of which does not reach up to the middle of the hydrotheca; all sarcothecæ are adcaulinally split. The hydrotheca margin is furnished with a strong, sharply cut median abcauline tooth; between this and the hydrocladium the margin is slightly dentate or curved, more faintly near the hydrocladium than farther from it. The opening margin stands almost perpendicular to the hydrocladium.

The gonothecæ proceed from a hydrocladium which is transformed into a narrow-bladed corbula having its blades (ribs) furnished with a basal hydrotheca, and in addition, on the outer side, numerous sarcothecæ. Between the corbula and the stem the hydrocladium has a varying number of hydrothecæ. The gonotheca is pear-shaped.

Material:

"Ingolf" St. 15	66°18' N.,	25°59' W.,	depth 330 fathoms	÷ 0,75°
— - 35	65°16' N.,	55°05' W.,	— 362 —	3,6°
— - 81	61°44' N.,	27°00' W.,	— 485 —	6,1°
"Thor" 63°18' N.,	21°30' W.,	depth 178 metres		
— 61°15' N.,	9°35' W.,	— 872 —		
Iceland: 3 miles E. of Bjarnaröi,	—	70 fathoms.		

Thecocarpus myriophyllum is undoubtedly the most frequently occurring *Aglaopheniid* in the eastern part of the North Atlantic (fig. L). It is therefore highly peculiar that it should now have been met with for the first time by the "Ingolf" in Davis Strait, where no specimen had previously been found. In Iceland waters also, reliable data have hitherto been extremely rare, though Sæmundsson (1911 p. 105) records the species from the south-west point of Iceland, albeit under the name of *Thecocarpus radicellatus*. We can now add the further finds in these waters from Danmark Strait and east coast of Iceland. *Thecocarpus myriophyllum* is a species belonging to the lower littoral

region of the warmer seas and the upper abyssal region; quite exceptionally it may penetrate deeper down, as seen from the above. In the boreal regions it is not altogether rare, and has even in a single instance been met with in the cold area.

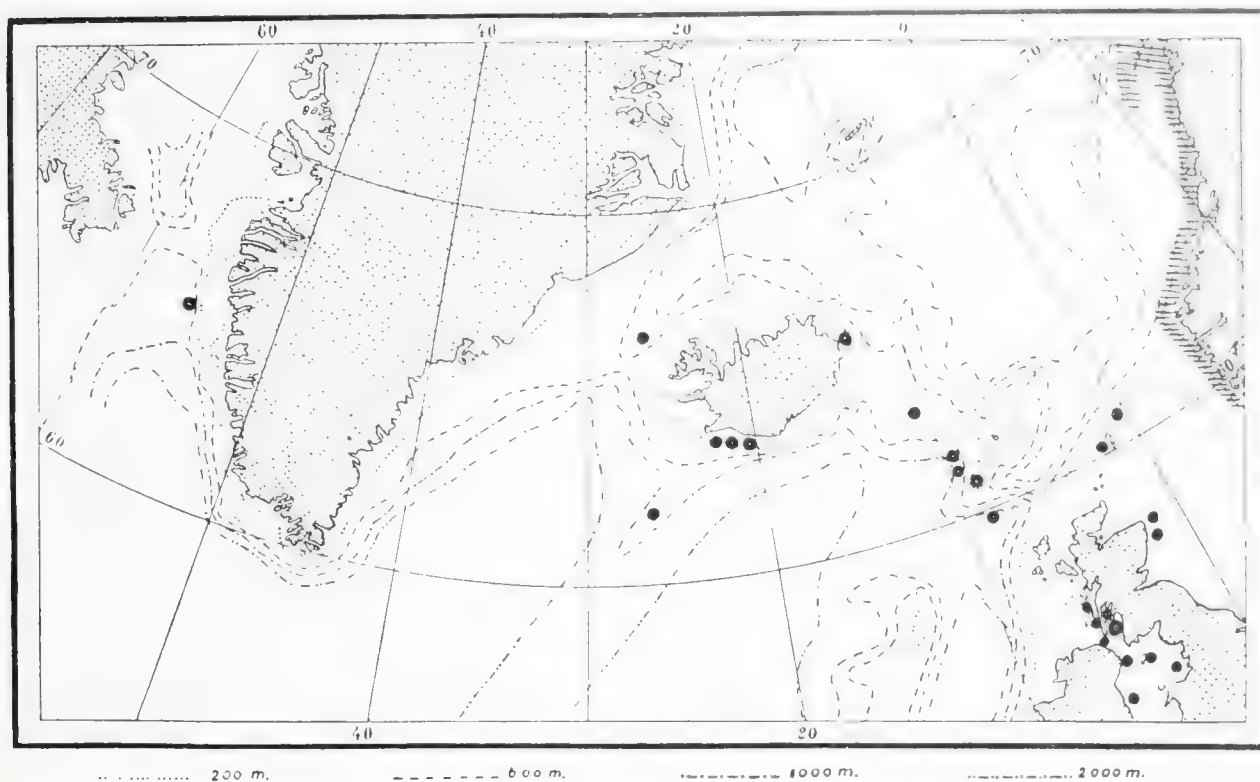


Fig. L. The distribution of *Thecocarpus myriophyllum* in the northern Atlantic.
In the hatched regions the literature notes a common, although scattered occurrence.

Gen. *Aglaophenia* Lamouroux.

Upright pinnate colonies with branched or unbranched main stem, the apophyses bearing unbranched hydrocladia with several hydrothecæ. All sarcothecæ immobile. Gonothecæ in a corbula formed by a metamorphosed hydrocladium; the corbula blades (ribs) are furnished with sarcothecæ, but lack hydrothecæ.

Aglaophenia tubulifera Hincks.

1861 *Plumularia tubulifera*, Hincks, A catalogue of the Zoophytes of South Devon, p. 256, pl. 7, figs. 1—2.

1868 *Aglaophenia tubulifera*, Hincks, A history of the British Hydroid Zoophytes, p. 288, pl. 63, fig. 2.

The colonies are pinnate with unbranched or branched monosiphonic main stem divided into short internodia. The internodium has close below the middle an apophyse directed obliquely forward and sideways, and three tubulose sarcothecæ, a pair at the upper side of the apophyse and an unpaired

one in the median line near the base. The internodia of the hydrocladia have each a hydrotheca and three sarcothecæ, a supracalycine pair near the hydrotheca aperture and a median proximal of greatly varying length. The proximal sarcotheca is tubulose, and has an open connection with the lumen of the hydrotheca; in the outer parts of the hydrocladium, it forms a more acute angle with the branch axis than nearer the stem; its free parts are in forma *typica* up to $\frac{2}{3}$ the length of the hydrotheca, in forma *Billardi* however, as a rule longer than the hydrotheca. The hydrotheca margin has an abcauline tooth, and on either side, between this and the hydrocladium, three, or more rarely four teeth. One or two internodial ribs are seen at the wall of the hydrotheca; at times an intrathecal rib may be indicated.

The gonothecæ are situate on a hydrocladium which has broad lateral blades converging to a corbula; the basal pair of blades is as a rule free, and hangs out and downwards; there is a hydrotheca between the corbula and the stem. The gonothecæ are pear-shaped.

Material:

"Thor", 35°57' N., 5°35' W., depth 740 metres.

The synonymy of the species has been dealt with in detail on a previous occasion (Broch 1912 p. 8) and notice has also been taken of the variations. Geographically, *Aglaophenia tubulifera* is a southern species, only quite exceptionally passing beyond the limit of the boreal waters round the British Isles; it belongs more especially to the middle and lower parts of the littoral region.

Family series *Sertulariina* nov.

Family *Sertulariidæ*.

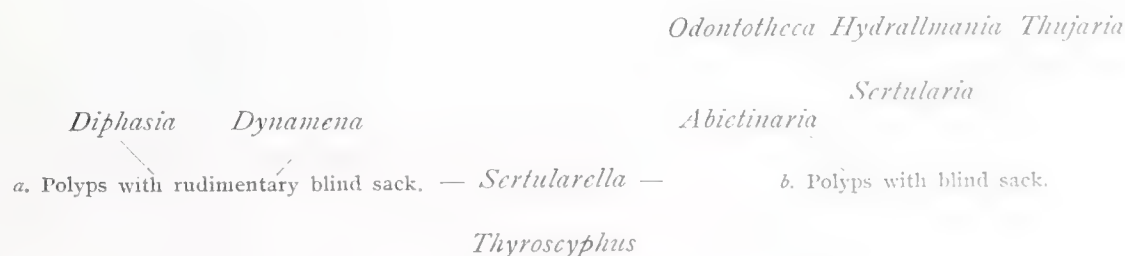
The hydrothecæ are bilateral in structure and furnished with closing apparatus formed of from one to four plates. The colonies form sympodia or monopodia with terminal growth point. The polyps have a more or less pronounced abcauline and basal blind sack with a low, non-digestive endodermal epithelium; they are therefore bilaterally symmetrical.

Few families have been the subject of so much dispute as the *Sertulariidæ*, both as regards limitation and also in respect of division into genera. The best foundation is that given by Levinsen in his latest work (1913) where he comes to the same result as Stechow (1913). The latter writer here separates off the *Syntheциidæ* as a distinct family comprising those forms which lack the lid; but while Levinsen also discards this group and refers it to the family *Lafoëidæ*, Stechow considers the *Syntheциidæ* as an independent family, most nearly related to the *Sertulariidæ* sens. strict — a view in which we may fully concur, owing to the homogeneous organisation of the polyps. This principle for division is not very fully dealt with by Levinsen, and in particular the special organisation of the abcauline blind sack and its endodermal peculiarities seem altogether to have escaped his attention. This is suggested, as already mentioned, by his reference to a blind sack in *Lactorella pinnata* (G. O. Sars) which from a purely anatomical point of view is hardly tenable. Com-

mon to *Synthechiidæ* and *Sertulariïdæ* is also the exterior ectoderm lamella, which forms an inner wall covering to the hydrothecæ; a parallel formation is, it would seem, found only in *Aglaopheniidæ*, where it is less pronounced. From the anatomical agreement of the polyps in the two families, and the fundamental differences in the structure of the polyps as compared with the remaining thecaphores, I have found it most correct to take the two families together in a distinct family series *Sertulariina*.

With regard to division into genera, however, I can on the whole agree with *Levinsen*, as will be seen from the following. Nevertheless it should be noted that the generic subdivision is still far from satisfactory. A considerable amount of anatomical investigation will be required before we can obtain a thoroughly adequate foundation here, and the present material, unfortunately, is not suitable for such studies.

In face of the above diagnosis, it may be objected that a genus such as *Diphasia* lacks the blind sack, at any rate, appears to do so. This point is not without importance, and has its own particular interest in consideration of the genus from a phylogenetic point of view. On closer examination of the group of species which *Levinsen* classes together in the genus *Sertularella*, we find that there are here, as a matter of fact, two distinct anatomical groups, which ought really to be separated as independent genera. The more restricted genus *Sertularella* will then comprise the species in which a closing apparatus consisting of 3 or 4 flaps is found together with polyps having fully developed abcauline blind sack; this class includes the great majority of species. On the other hand we have a group of species with the same sort of closing apparatus, but with polyps in which the blind sack is rudimentary or entirely lacking as far as can be seen from external observation. For this group, then, a special genus should be established. The group in question exhibits a close affinity to *Thyroscyphus*, which again forms a link with *Campanulinidæ*, and from this genus we must presume that the entire family has its origin. A species such as *Sertularella tamarisca* (Linné) belongs to this group of the *Sertularella*, and represents the transition stage to genera with rudimentary blind sack, *Diphasia* and *Dynamema*. From the second group, again, are derived the remaining genera with their marked lines of development in the closing apparatus. Taking into consideration both the organisation of the hydranth, and the structure and development of the closing apparatus, we come to fixed lines of development within the family, which are best illustrated by the following scheme:



Gen. *Sertularella* Gray.

Upright colonies with sympodial growth. The opening of the hydrotheca is furnished with three or four marginal teeth, between which are attached as many triangular opercular plates closing in a pyramid over the aperture.

The definition here agrees with that given by Levinsen (1913 p. 30). The genus seems, however, to form a somewhat heterogeneous collection of species which should, probably, from the structure of the polyp, be divided into two groups or genera. Of these groups, *Sertularella* sens str. will then comprise species with abcauline blind sack, while in the other group, we have species where this is rudimentary or indiscernible on external observation. The latter group leads, as above mentioned, to *Diphasia* and *Dynamena*, while the former gives the point of origin for the remaining genera of *Sertulariidae*. The most primitive group is that of the species without visible blind sack.

Sertularella tamarisca (Linné) Levinsen.

1758 *Sertularia tamarisca*, Linné, Systema naturæ, ed. 10, p. 808.

1893 *Sertularella tamarisca*, Levinsen, Meduser, Ctenophorer og Hydroider, p. 58.

Upright, somewhat irregularly branched, as a rule pinnate colonies, without distinct main stem. The hydrothecæ, which have a tripartite lid and tridentate opening margin, are set in two rows along the branches, a pair of hydrothecæ oppositely placed on each internodium. The hydrothecæ are very large, almost cylindrical, with the distal half free and highly diverging from the branch.

The male gonothecæ are reversed conical, compressed distally with a small tooth on either side and a short cylindrical neck centrally placed. The females are of the same shape, but have three distal broad blades, each furnished with a longitudinal indented median ridge; the three blades close in to a pyramid and form a large external marsupium, in which the larvæ are developed.

Material:

"Ingolf" St. 11, 64°34' N., 31°12' W., depth 1300 fathoms, 1,6°

— - 87, 65°02,3' N., 23°56,2' W., — 110 —

— - 95, 65°14' N., 30°39' W., — 752 — 2,1°

— - 98, 65°38' N., 26°27' W., — 138 — 5,9°

— - 144, 62°49' N., 7°12' W., — 276 — 1,6°

"Thor" 63°30' N., 20°14' W., — 80 metres

Iceland: 6 miles W. of Isafjord, depth 55 fathoms

5 — E. of Seydisfjord, — 135

63°21' N., 17°15' W., — 58 —

The Faroe Islands: 16 miles S. by E. of south point of Nolsö, depth 80 fathoms.

Sertularella tamarisca presents, as a matter of fact, a somewhat alien impression among the remaining *Sertularella* species, and has led an unsettled existence, now in this genus, now in *Diphasia* " *Dynamena*. The paired arrangement of the hydrothecæ and the remarkable female gonothecæ of

the species, with the marsupial chamber resembling that of *Diphasia fallax* (Johnston) and *Diphasia rosacca* (Linné) have led to its being frequently referred to this genus. The state of the material did not permit of a quite certain investigation of the polyps, but as far as it was possible to judge it has a quite rudimentary blind sack, which brings the species nearer to *Diphasia*. On the other hand, the closing apparatus is altogether of the same type as *Sertularella*, thus removing the species again from *Diphasia*. The most natural thing would doubtless be to consider *Sertularella tamarisca* as the type of a distinct genus, which in a certain degree forms a link between the true *Sertularia* species and *Diphasia*. This would demand, however, in the first place a closer study of the structural

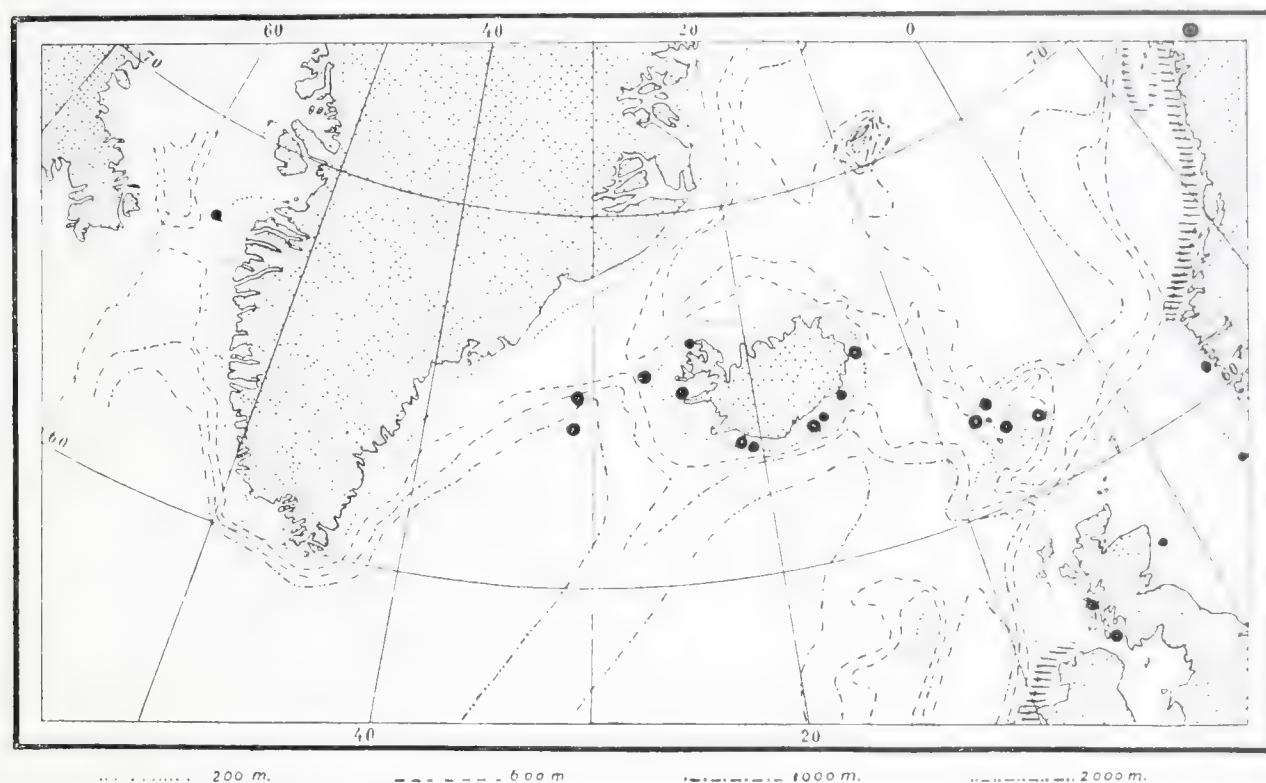


Fig. LI. The distribution of *Sertularella tamarisca* in the Northern Atlantic.

In the hatched regions the literature notes a scattered occurrence without giving particular data.

conditions of the species, and as my material is not suited to the purposes of such investigation, I have for the present refrained from establishing the new genus here.

It is not altogether easy to determine with certainty the biogeographical character of the species. *Sertularella tamarisca* is not a form of frequent occurrence, and is never met with in large numbers at a time; on the contrary, it is as a rule taken in single specimens, so that the species appears to be somewhat of a rarity. Further study seems to show that it is a boreal species capable of penetrating slightly into the arctic area and even more into warmer waters. Towards the north, it comes up into the White Sea, and towards the south, as we know, it penetrates into the Mediterranean. In the waters investigated (fig. LI) the species has not infrequently been found in the eastern part of the boreal region, while it has only once been met with in Davis Strait; it never penetrates into the cold area, despite the fact that its wide bathymetrical range would seem to suggest a con-

siderable elasticity in respect of physical conditions. The chief occurrence of the species falls in the lower part of the littoral region and the upper part of the abyssal.

***Sertularella tricuspidata* (Alder) Hincks.**

1856 *Sertularia tricuspidata*, Alder, A notice of some new genera and species, p. 356, pl. 13, figs. 1—2.

1868 *Sertularella tricuspidata*, Hincks, A History of the British Hydroid Zoophytes, p. 239, pl. 47, fig. 1.

Upright colonies with pinnate or quite irregularly bushy ramification; in the pinnate colonies, the branches are alternating or subalternating, not infrequently they may themselves be dichotomically or pinnately branched; the branches are often bent or twisted. The monosiphonic stem and branches are segmented; each internodium has a hydrotheca. The hydrothecæ are situate on the distal part of the internodium, and are cylindrical or slightly barrel-shaped, with their narrowest part immediately below the aperture; they have three teeth of equal size on the aperture margin, the one median adcauline; in the sinuses between the teeth, the three triangular plates of the closing apparatus are attached. The adcauline wall of the hydrotheca has a free distal part between half and two-thirds the length of the hydrotheca. The polyp has a well-developed abcauline blind sack.

The gonothecæ are attached under the base of the hydrothecæ. They are oval to pear-shaped, with a short and narrow, reversedly conical, distally central neck, and with deep transverse furrows.

Material:

“Ingolf”, beach of Jan Mayen.

—	St. 3	63°35' N.,	10°24' W.,	depth 272 fathoms	0,5°
—	- 34	65°17' N.,	54°17' W.,	55	—
—	- 54	63°08' N.,	15°40' W.,	— 691	— 3,9°
—	- 87	65°02,3' N.,	23°56,2 W.,	— 110	— —
—	- 95	65°14' N.,	30°39' W.,	— 752	— 2,1°
“Thor”		65°52' N.,	23°58' W.,	— 62 metres	
—		65°29,5' N.,	24°63' W.,	— 40	—
—		64°02' N.,	22°33' W.,	— 34	—
—		63°30' N.,	20°14' W.,	— 80	—

Greenland: mouth of Nerak (depth not stated)

Hunde-Eiland (— - —)

Egedesminde, depth 30—40 fathoms

Store Hellefiskebanke, — 24 —

Sukkertoppen, on *Boltenia* (without further details)

Frederikshaab (— — —)

Iceland: Bakkefjord, depth 25—32 fathoms

Lónafjord, — 40 —

Malarif (depth not stated)

Reydarfjord, — 60—80 — [labelled *Sertularella polyzonias*]

63°21' N., 17°15' W. — 58 —

Iceland: Vestmanö, depth 25 fathoms

10 miles W. of Akranes (depth not stated) [labelled *Sertularella polyzonias*,

Bredebugt, depth 7—12 fathoms

65°00' N., 24°38' W., — 22 —

Önundarfjord — 10 —

Adalvik (depth not stated).

The Faroe Islands: 7 miles N. by E. of Myggenæs point, depth 57 fathoms

6 — N. by W. of Store Kalsö, — 60

Deep hole at north point of Nolsö, — 100

5 miles S.S.E. of Bispen, — 50

Sertularella tricuspidata is a circumpolar arctic species which is extremely numerous in arctic waters. From there it penetrates far down into the boreal area (fig. LII) where it is one of the most common species, especially round the Faroe Islands, Iceland, and off West Greenland. Along the east coast of Greenland, however, it is distinctly rare. Its infrequent occurrence off the north coast of Iceland on the other hand, should probably rather be apparent, as the result of insufficient investigations. Along the west coast of Norway, *Sertularella tricuspidata* goes southward as far as Bergen; according to the literature, it is also met with near the British Isles, but we have no certain data from here, so it would seem that this must be about the limit of its distribution. Bathymetrically, it belongs to the littoral region, exceptionally, however, it may, as shown by the find at the "Ingolf" St. 95, penetrate quite far down into the abyssal.

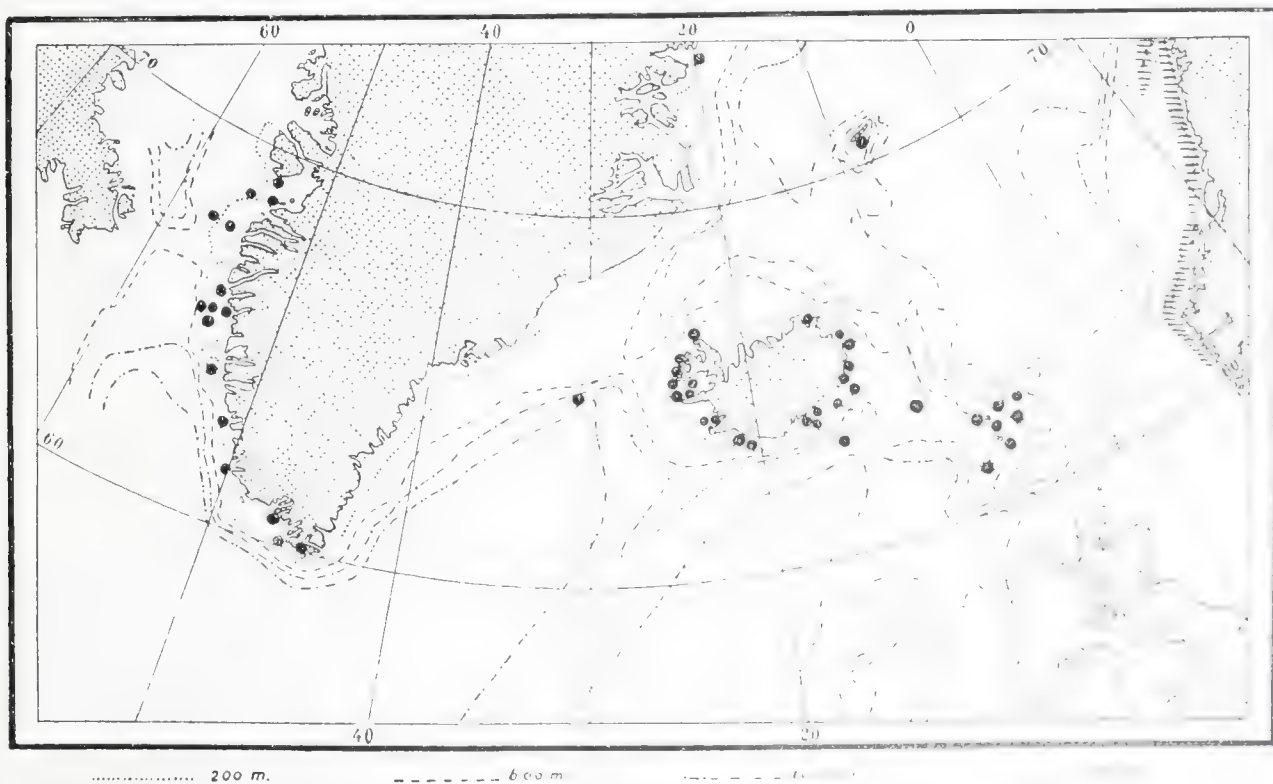


Fig. LII. The distribution of *Sertularella tricuspidata* in the Northern Atl.
In the hatched regions the literature notes a scattered occurrence.

Sertularella amphorifera Allman.

1877 *Sertularella amphorifera*, Allman, *Hydroida* of the Gulf Stream, p. 22, pl. 15, figs. 8—10.

1912 *Sertularella amphorina*, Bedot, *Matériaux pour servir à l'histoire des Hydroides*, 4^{me} période, p. 352.

Upright slender colonies with monosiphonic hydrocaulus. Stem and main branches slightly prominent. The basal part of the stem is straight, irregularly segmented, without hydrothecæ and branches; higher up, it becomes regularly segmented, like the branches, with a hydrotheca on the distal part of each internodium. The branches arise in irregular alternation, and may themselves again ramify; like the hydrotheca-bearing part of the main stem, they are bent zigzag fashion. The hydrothecæ are large, cylindrical, slightly curved, with three equal sized, markedly prominent teeth,³ and in the sinuses between them three large triangular lid plates. The hydrotheca is attached to the branch by a narrow base. The polyp has a distinctly prominent abcauline blind sack.

The gonothecæ proceed from below the base of the hydrothecæ. They are a slender oval to pear-shaped, with a distally central narrow neck, and distinct transverse furrows; the neck passes evenly over into the gonotheca.

Material:

"Ingolf" St. 7, 63°13' N, 15°41' W.; depth 600 fathoms, 45°

— - 54, 63°08' N, 15°40' W.; — 691 — 39°

Nutting (1904 p. 88) who had only some fragments of Allman's type specimen to work on, states that *Sertularella amphorifera* has possibly four hydrothecal teeth, and he gives some drawings where four such teeth are markedly in evidence, as if his specimen had been intact, and not, as he himself expressly notes in the text, defective. Billard (1906 p. 183) on the other hand, reports the species as distinctly tridentate, and this is also plainly to be seen from my specimens (fig. LIII). Between two branches on the stem, the number of hydrothecæ varies from two to five.

Sertularella amphorifera is evidently very closely related to *Sertularella tricuspidata*, extreme variants of which may present a strong resemblance to the former. On the whole however, *Sertularella amphorifera* seems to be of considerably more open growth, while its finer structure and long, slender internodia, together with the strongly projecting hydrothecæ, give it a typically different appearance from *Sertularella tricuspidata*, as is apparent at the first glance.

The finding of *Sertularella amphorifera* so far to the north is highly interesting. It was previously known only from the sea off Florida at Double Headed Shot Key, 471 fathoms, and from the west coast of Africa, where it was taken at 882 metres' depth. The species thus belongs to the warmer parts of the Atlantic abyssal region, and moves up, in the warm, deep water layers, to the deep off the south-east coast of Iceland.

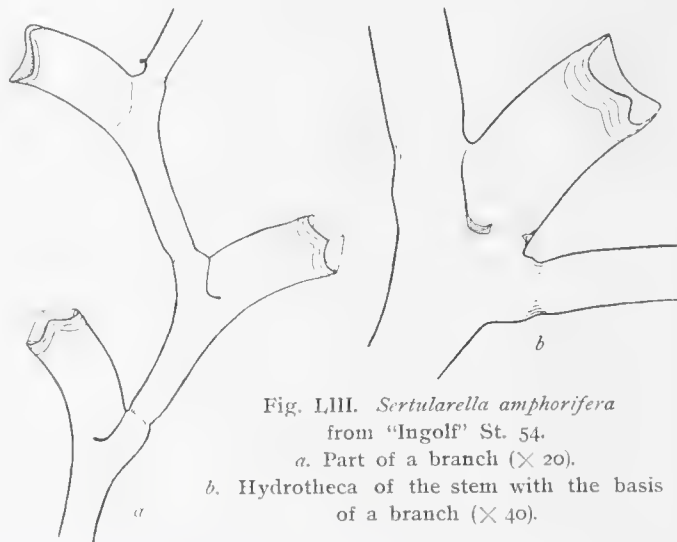


Fig. LIII. *Sertularella amphorifera* from "Ingolf" St. 54.

a. Part of a branch (× 20).

b. Hydrotheca of the stem with the basis of a branch (× 40).

***Sertularella polyzonias* (Linné) Gray.**

1758 *Sertularia polyzonias*, Linné, *Systema naturæ*, ed. 10, p. 813.

1848 *Sertularella polyzonias* var. *a*, Gray, *List of the specimens of british animals*, p. 68.

Upright colonies with irregularly branched monosiphonic hydrocaulus, no distinct main stem. The branches are divided by oblique nodes into internodia, each bearing a hydrotheca, turning alternately to either side. The hydrothecæ are smooth or slightly wrinkled transversely, barrel-shaped, with a somewhat expanded opening part; the opening margin has four low and broad teeth, between which are attached the four triangular lid plates. The adcauline wall has a longer or shorter free part, according as the hydrotheca diverges more or less sharply from the branch. The polyp has a well-developed abcauline blind sack.

The gonothecæ proceed from close under the base of the hydrothecæ. They are egg-shaped, deeply furrowed transversely throughout their entire length, and have four markedly prominent strong teeth about the distally central opening.

Forma *typica*: fine and low colonies.

Forma *gigantea* (Mereschkowsky): large robust colonies.

Material:**Forma *typica*:**

Iceland: Bredebugt, depth 35 fathoms (transitional to forma *gigantea*).

63°20' N., 20°14' W., depth 80 metres.

The Faroe Islands: 6 miles N. by W. of Store Kalsö, depth 60 fathoms.

Forma *gigantea*:

"Ingolf" St. 127 66°33' N., 20°05' W., depth 44 fathoms

Greenland: Akudlek — 30—60 — [labelled *Sertularella polyzonias*]

Jakobshavn (depth not stated) [— — —]

Egedesminde — - —

Store Hellefiskebanke (without further details)

— — depth 32 fathoms

Godthaab (without further details) [labelled *Sertularella polyzonias*]

Davis Strait, 67°34' N., 55°29' W. [— — —]

Sukkertoppen on *Boltenia* (depth not stated)

Kara Sea, "Dijmphna" [labelled *Sertularella polyzonias*].

Sertularella polyzonias is divided by many writers into two species, the gigantic arctic form being regarded as a distinct species, *Sertularella gigantea* Mereschowsky. Kirchenpauer (1884 p. 34) has already drawn attention to the existence of intermediate forms between the two, which cannot show a single qualitative difference, the latter for instance, being distinguished merely by the fact that all dimensions are harmoniously increased. The very fact that this form belongs to the arctic and antarctic water layers, while the other is quite cosmopolitan, warns us to be careful about regarding them as distinct species. Geographical studies on the variations of hydroids have shown (cf. Broch 1909,

1913, 1914) that the dimensions may here quite commonly become coarser within the same species as the temperature decreases. In *Sertularella polyzonias* forma *gigantea*, this common law has been followed to an extreme, while the transition forms are comparatively few. That they exist, however, is plainly evident from the present material, where in particular certain colonies from Jakobshavn, Greenland, and all those from Bredebugt take up a doubtful intermediate position.

Forma *gigantea* (fig. LIV) is a typical arctic (and antarctic) character form, only exceptionally capable of penetrating into the boreal region. It is extremely common in West Greenland waters, and is also known from East Greenland; occasionally also from the north coast of Iceland. Forma *typica*, on the other

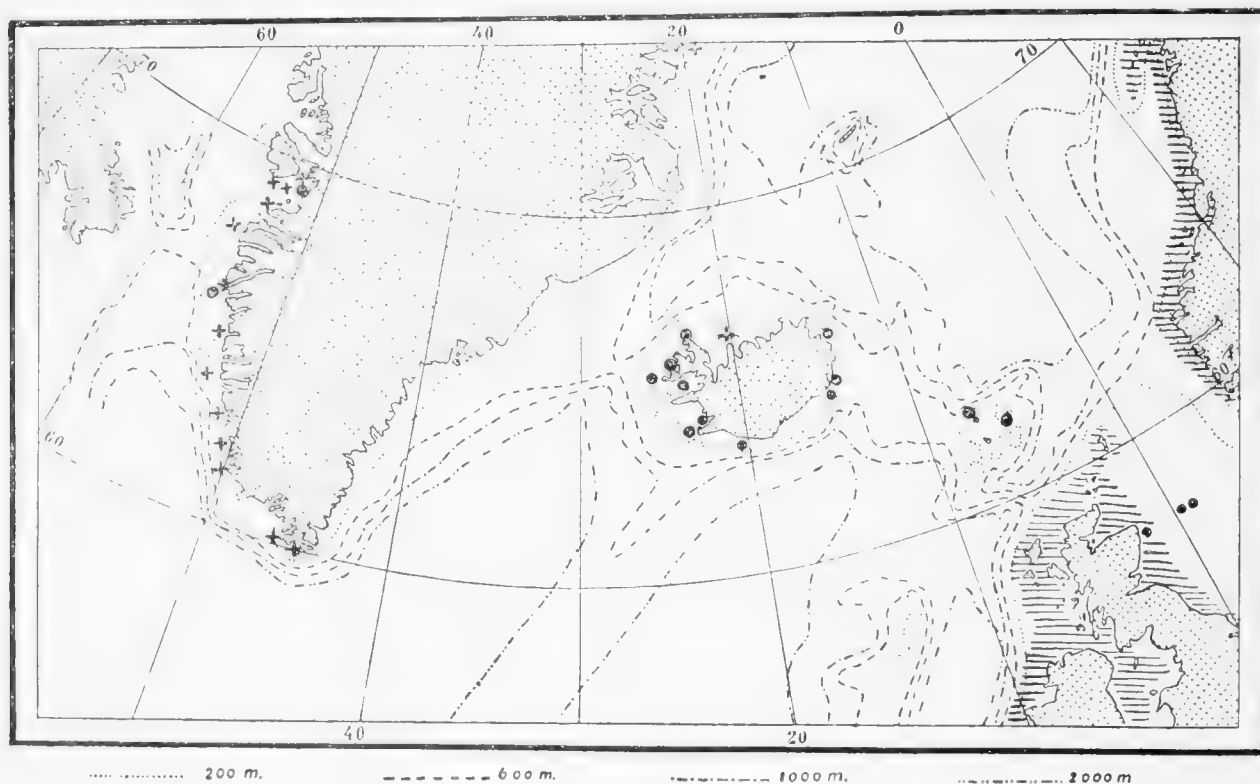


Fig. LIV. Finds of *Sertularella polyzonias* forma *typica* ● and forma *gigantea* + in the Northern Atlantic.

In the hatched regions the literature notes a common occurrence of the forma *typica*.

hand, is cosmopolitan, and occurs also, albeit less frequently, in arctic waters. In the boreal area, it is particularly numerous in the eastern parts. Both forms belong to the middle parts of the littoral region, and rarely move down into the deep sea region.

Sertularella Gayi (Lamouroux) Hincks.

1821 *Sertularia Gayi*, Lamouroux, Exposition méthodique des genre . . . p. 12, pl. 66, figs. 8—9.

1868 *Sertularella Gayi*, Hincks, A History of the British Hydroid Zoophytes, p. 237, pl. 46, fig. 2.

Upright, irregular doubly pinnate colonies with distinctly prominent polysiphonic main stem and main branches. The outer branches are almost regularly pinnately branched often with their minor branches secondarily ramified. The outer branches are divided by indistinct oblique joints into short internodia, having on their distal half a large hydrotheca; the hydrothecæ are directed alternately to

either side in the broad plane of the colony. The hydrotheca has a free adcauline distal wall part, half as long as the hydrotheca or somewhat less, about $1\frac{1}{2}$ times the opening diameter. The hydrotheca has its greatest breadth at the middle, and narrows down both towards the base and towards the opening, which is set perpendicular to the axis of the hydrotheca. The free portion of the adcauline wall is as a rule furnished with somewhat faintly marked transverse furrows. The opening margin has four low teeth and four triangular lid plates in the sinuses between them.

The gonothecæ proceed from the branches close under the base of the hydrothecæ. They are oval, more or less furrowed transversely in the distal half, and have distally a narrow central opening with two diametrically opposite short broad teeth.

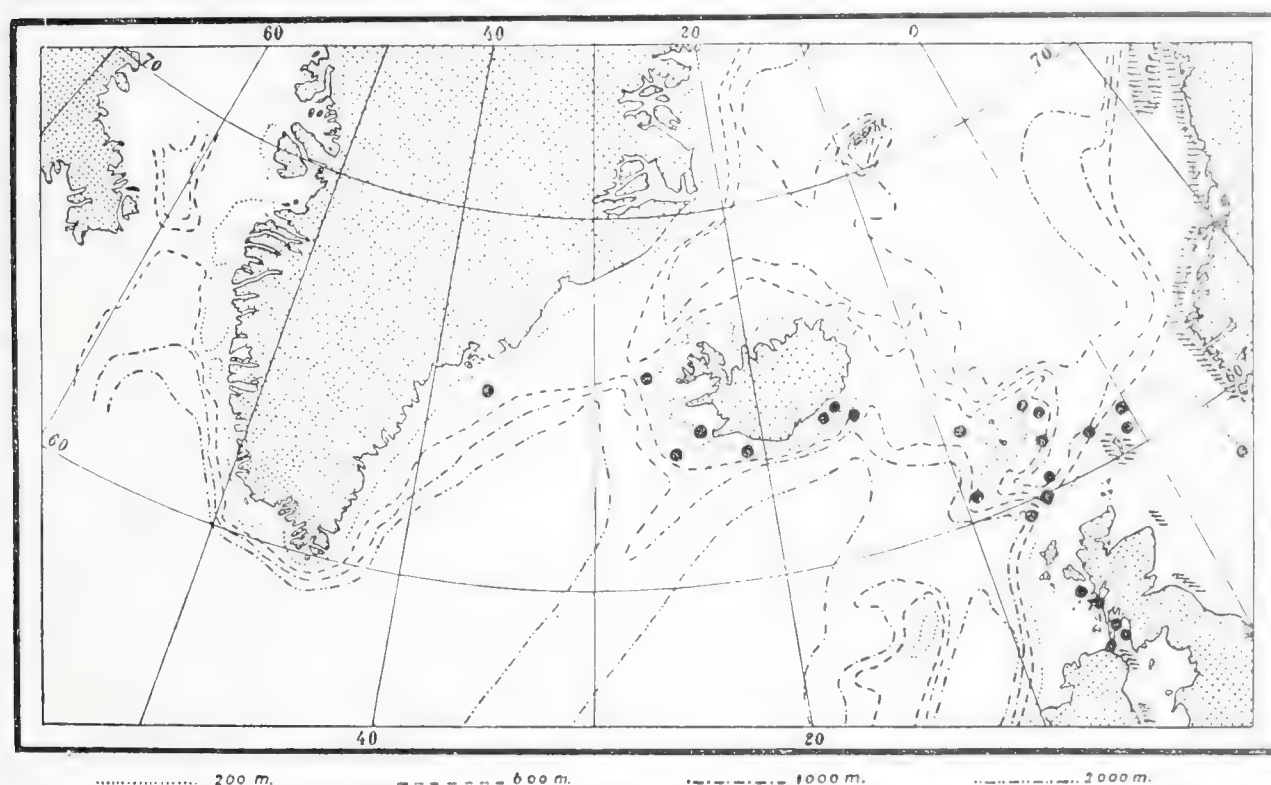


Fig. LV. The distribution of *Sertularella Gayi* in the Northern Atlantic.

In the hatched regions a common although scattered occurrence is stated in the literature without precise data.

Material:

"Ingolf" St.	1	62°30' N.,	8°21' W.,	depth 132 fathoms	7,2
—	- 55	63°33' N.,	15°02' W.,	— 316	— 5,9
—	- 85	63°21' N.,	25°21' W.,	— 170	—
—	- 94	64°56' N.,	36°19' W.,	— 204	— 4,1
—	- 98	65°38' N.,	26°27' W.,	— 138	— 5,9 ^c
"Thor"		64°06' N.,	23°14' W.,	— 98 metres	labelled <i>Sertularella</i>
Iceland: Ingolfshöfði 9½ miles in N. by E. 1½ E., depth 53 fathoms.					
The Faroe Islands: 60°23' N., 8°55' W., — 225					

Sertularella Gayi is an atlantic warm-water species, which in the northern waters (fig. LV) exhibits an easterly distribution. It belongs to the deeper littoral and upper abyssal regions, where it is particularly frequent. In the south-eastern part of the boreal area it is quite common, and moves hence down into the cold area in the Faroe Channel; it is not altogether rare off the south coast of Iceland, where it seems now and again to have been confused with *Sertularella polyzonias*. The "Ingolf" has a single specimen from St. 94, so that the species can also occur in deep water off the south-east coast of Greenland, outside the mouth of Danmark Strait, where the deeper parts are still covered with warmer atlantic water layers.

Sertularella tenella (Alder) Hincks.

1856 *Sertularia tenella*, Alder, A notice of some new genera and species, p. 357, pl. 13, figs. 3—6.

1868 *Sertularella tenella*, Hincks, A History of the British Hydroid Zoophytes, p. 242, pl. 47, fig. 3.

Upright, unbranched or slightly branched openly constructed colonies with monosiphonic hydrocaulus. Stem and branches are divided by joints into not very long internodia, each having on its distal part a very slightly imbedded hydrotheca; proximally, the internodium is furnished with a pair of rings. The stem and branches are bent to an angle at the nodes, which gives them a markedly zigzag course. The hydrothecæ are large, about as long as the internodia, elongated oval, with somewhat more cylindrical opening part; they are distinctly furrowed transversely between the base and the cylindrical opening part. The aperture is set perpendicular to the longitudinal axis of the hydrotheca. The opening margin has four low teeth, and in the sinuses between them four triangular lid plates. The polyp has a well-developed abcauline blind sack.

The gonothecæ proceed from stem and branches close under the base of the hydrothecæ. They are oval to more pear-shaped, transversely furrowed throughout their entire length, and furnished with a distal central short, almost cylindrical neck.

Material:

"Ingolf" St. 94 64°56' N., 36°19' W., depth 204 fathoms 4,1°

— - 95 65°14' N., 30°39' W., — 752 — 2,1°

As a synonym to this species I have previously (1909 p. 126) noted *Sertularella pellucida*. Jäderholm has, however, (1909 p. 99, Taf. XI, figs. 8—11) given a closer study of this species, from which it appears that it does not belong here, its entire structure being different, and the colonies more resembling those of *Sertularella fusiformis*.

Kramp (1914 p. 1037) characterises *Sertularella tenella* as a cosmopolitan species. This must, however, as will be seen from the chart (fig. LVI) be taken with some little reserve. The species is altogether more sporadic in its occurrence within the northern waters, save probably for the tracts immediately round the British Isles, where it appears to be more common. Otherwise, it follows in the northern areas the same laws as do the warmer atlantic species, and is somewhat rare in the strictly boreal water layers. v. Lorenz, (1886) mentions the species from Jan Mayen, but this determination would seem, from the remaining data, to be somewhat uncertain.

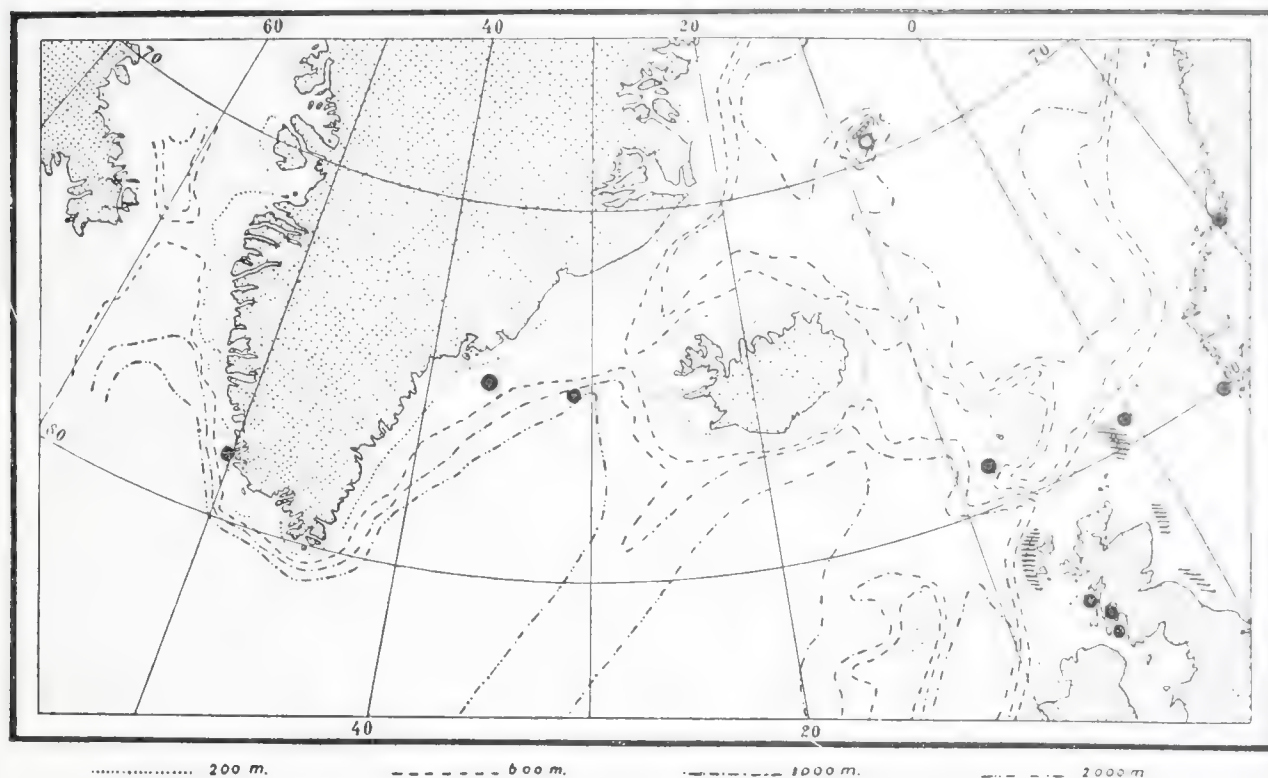


Fig. LVI. Finds of *Sertularella tenella* in the Northern Atlantic;
In the hatched regions the data are not altogether precise. (◊ doubtful locality).

Sertularella fusiformis Hincks.

1861 *Sertularia fusiformis*, Hincks, A Catalogue of the Zoophytes of South Devon, p. 253, pl. 6, figs. 7—8.

1868 *Sertularella fusiformis*, Hincks, A History of the British Hydroid Zoophytes, p. 243, pl. 47, fig. 4.

1907 *Sertularella pellucida*, Jäderholm, Über einige nordische Hydroiden.

1909 *Sertularella pellucida*, Jäderholm, Northern and Arctic Invertebrates, p. 99, Taf. 11, figs. 8—11.

Open and finely built, zigzag and slightly branched upright colonies with monosiphonic stem. The stem and branches are divided into short internodia which form an angle one with another, and are more or less distinctly ringed, more rarely quite smooth. From the same internodium may often proceed two or three branches, or simple internodia. The large, somewhat spindle-shaped hydrothecae are situated on the outer half of the internodium, and are very slightly embedded; the opening part is again as a rule somewhat expanded; the aperture is set perpendicularly to the axis, and has four not very prominent teeth, between which are attached four triangular lid plates.

The gonothecae are attached to the branches or stolons. They are elongated oval to egg-shaped, in the latter case with the broader part somewhat below the middle. The gonotheca has a distal central aperture with four strong teeth.

Material:

"Ingolf" St. 3 63°35' N., 10°24' W., depth 272 fathoms, 0.5°.

Sertularella fusiformis assumes a highly characteristic appearance from the peculiarity that it has often on stem or branches two or three short branchlets proceeding simultaneously from the same point, these short branchlets consisting of a single internodium, or more rarely a couple, with large hydrothecæ almost terminally placed. An excellent picture of this is given by Jäderholm (1909 Taf. 11, fig. 9). His specimens undoubtedly belong to *Sertularella fusiformis*, and are only remarkable in having the internodia entirely smooth; here, however, all transition stages occur, so that we are not warranted in setting aside the specimens on such ground as types of a distinct species.

Sertularella fusiformis is probably a warm atlantic species, but its occurrence is little known. In the waters investigated, it is previously known from the Hebrides, and from the Clyde Sea area; to these, Jäderholm adds a single find from Spitzbergen, and the species has now also been taken by the "Ingolf" about midway between the Faroe Islands and Iceland.

Sertularella rugosa (Linné) Hincks.

1758 *Sertularia rugosa*, Linné, Systema naturæ, Ed. 10, p. 809.

1868 *Sertularella rugosa*, Hincks, A History of the British Hydroid Zoophytes, p. 241, pl. 47, fig. 2.

Upright, irregularly branched small colonies without pronounced main stem; the latter is monosiphonic. The colony is divided by oblique nodes into short internodia, each bearing a hydrotheca directed alternately to either side, and situate on the upper half of the internodium. The hydrothecæ are broad oval or barrel-shaped, with deep transverse furrows, which are particularly marked on the abcauline side, where a very deep furrow is always found immediately beneath the aperture. The opening forms an angle with the hydrotheca axis, and is turned away from the branch; it is furnished with four low, often somewhat indistinct teeth, between which four triangular lid plates are attached.

The polyp has a large abcauline blind sack.

The gonothecæ proceed from the internodia close under the hydrothecæ. They are egg-shaped or more oval, with deep transverse furrows, and have distally a central broad opening, surrounded by four short strong teeth.

Material:

Jan Mayen, depth 15 fathoms (East Greenland expedition).

Iceland: Grindavik (depth not stated)

10 miles W. of Akranes, on algæ

Stykkisholm, depth 30 fathoms

Bredebugt (without further details)

The Faroe Islands: Solmunde, on algæ

Thorshavn, on algæ, depth 3—4 fathoms.

Vestmanhavn, — 3.5—4 —



Fig. LVII. Hydrothecæ.
of *Sertularella rugosa*
from Herlû near Bergen
(X 40).

The available illustrations of *Sertularella rugosa* are very little characteristic, and this applies especially to Nutting's (1904 pl. 17, figs. 1—5) which present an entirely misleading impression, inasmuch as they suggest that the hydrothecæ are distinctly ringed. A new drawing is therefore given here (fig. LVII) showing the deep transverse furrows; particularly characteristic is the deep abcauline furrow beneath the aperture.

Sertularella rugosa must be characterised as a boreal species, having its bathymetrical distribution in the upper half of the littoral region, though it does not often penetrate up into the tidal zone. Kirchenpauer (1884) records it as found at Greenland, but there are no subsequent finds recorded from there. In the areas investigated (fig. LVIII) it has, it will be seen, an easterly distribution from Iceland to up in the Barents Sea, but its occurrence in the purely arctic area is quite sporadic, while on the west coast of Norway, for instance, it is a characteristic species in the laminaria zone. New finds are those from the Faroe Islands, where the species might be expected to be found from its occurrence off the coasts of Iceland, the British Isles, and Norway.

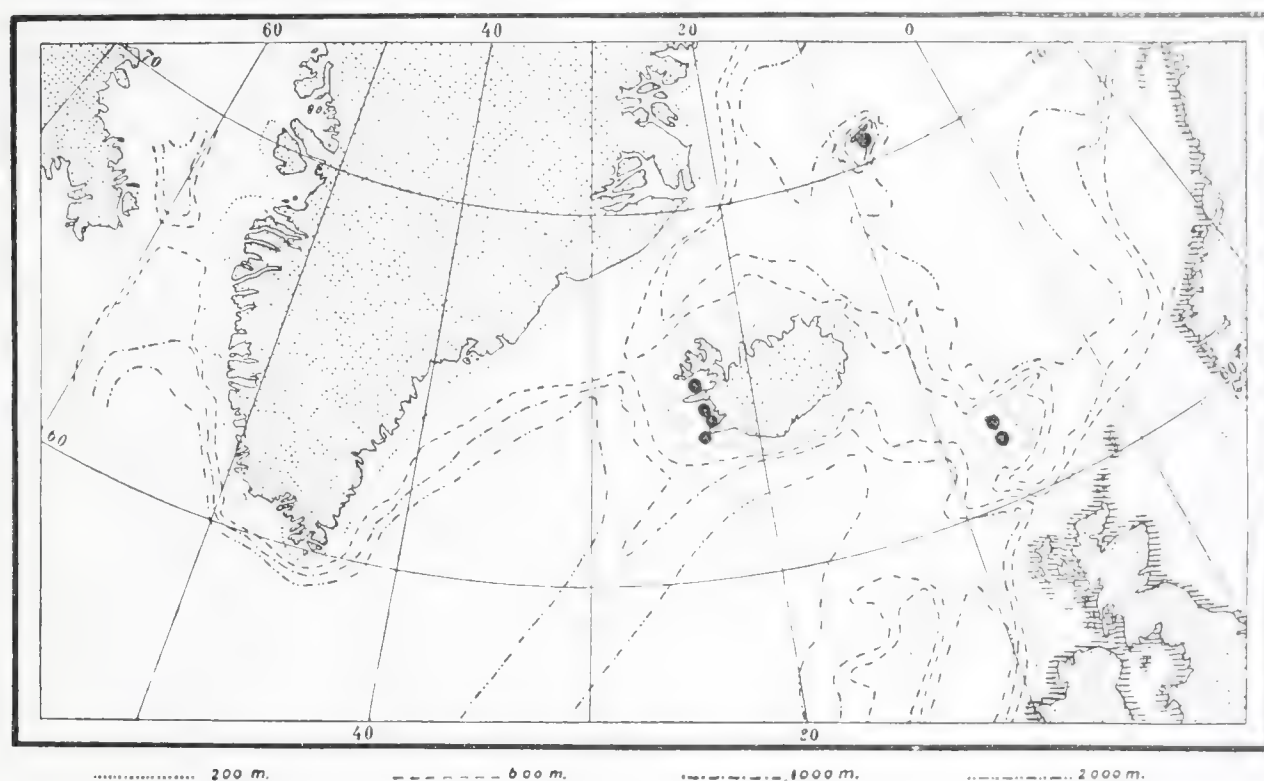


Fig. LVIII. Distribution of *Sertularella rugosa* in the Northern Atlantic.

In the hatched regions a common occurrence is noted.

Diphasia Agassiz.

Upright colonies, the hydrothecæ having a horizontal or slightly obliquely situated aperture without distinct teeth, but as a rule with an adcauline sinus, in which the large single opercular plate is attached. The polyps have, as far as can be seen from external observation, no abcauline blind sack.

This definition differs in one important feature from that given by Levinsen (1913 p. 309), the organisation of the polyps being taken into consideration. We thus obtain a stronger and more natural limitation, and the genus then practically coincides with the group *Eudiphasia* Broch. It has long been a doubtful question whether the two groups *Eudiphasia* and *Abictinaria* should be assigned generic rank or not, attention having previously been paid only to the form of the hydrotheca as the decisive point, and distinction thus made between species having more cylindrical hydrothecæ or hy-

drothecæ expanding distally (*Eudiphasia*) from those in which the hydrothecæ are bottle-shaped (*Abietinaria*). There are, however, transition forms, and the great variation in the hydrothecæ in most species renders a limit such as that so drawn extremely vague.

We now find, however, that the structure of the polyp is different in the two groups, the blind sack being only in the latter found in full development. This is an organisational feature of so considerable importance as not only to warrant, but even to demand, a generic distinction between the two groups, which also on the whole present interesting points of difference in the gonangia. In *Diphasia*, we find that the female gonothecæ are as a rule furnished with spinous or leaf-shaped outgrowths, which very often fold in together, forming a distal chamber for the brood, a marsupium. This is a biological phenomenon, and from a phylogenetic point of view of less importance; on the other hand, it is interesting to note that it here appears to occur as a constant characteristic in a whole series of related species. It is also worth noting that this feature is likewise found in *Sertularella tamarisca* (Linné) a species which appears to form a link between *Sertularella* and *Diphasia*.

Diphasia fallax (Johnston) Al. Agassiz.

1847 *Sertularia fallax*, Johnston, A History of the British Zoophytes, p. 73, pl. 11, figs. 2, 5, 6.

1865 *Diphasia fallax*, Al. Agassiz, Illustrated Catalogue, p. 142.

Upright pinnate colonies with more or less pronounced monosiphonic main stem, and as a rule with convex foreside. Stem and branches are divided into internodia, each bearing a pair of oppositely placed hydrothecæ. The branches proceed alternately from the stem, and are themselves often sparsely branched, frequently with tendril-like terminal parts. Between two successive branches on the same side of the stem there are two to four hydrothecæ, the one of them being at the corner of the branch. The hydrothecæ are deeply embedded, with a free distal part of the adcauline wall, in length equal to the opening diameter, or slightly less. The aperture is round, the margin with adcauline sinus, in which the large opercular plate is attached. The greatest diameter of the hydrotheca is at the opening.

The gonothecæ are situate on the upper side of the branch or on the fore side of the colony. The males are pear-shaped, with four distal short broad spines, and a short conical to cylindrical central neck. In the females, the four spines have developed into four broad triangular blades, which close in together over a distal brood-chamber in which the larval development takes place.

Material:

"Ingolf" St.	3,	63°35'	N.,	10°24'	W.,	depth	272 fathoms	0,5°	Variety.
—	-	51,	64°14'	N.,	14°22'	W.,	— 68	— 7,32°	—
—	-	87,	65°02,3'	N.,	23°56,2'	W.,	— 110	—	—
	-	93,	64°24'	N.,	35°14'	W.,	— 767	— 1,46°	—
—	-	94,	64°56'	N.,	36°19'	W.,	— 204	— 4,1°	—
—	-	95,	65°14'	N.,	30°39'	W.,	— 752	— 2,1°	—
—	-	96,	65°24'	N.,	29°00'	W.,	— 735	— 1,2°	—
	-	98,	65°38'	N.,	26°27'	W.,	— 138	— 5,9°	—
—	-	115,	70°50'	N.,	8°29'	W.,	— 86	— 0,1°	—

- "Thor" 66°19' N., 23°27' W., depth 115—120 metres. Variety.
 — 65°52' N., 23°58' W., — 62 —
 — 63°30' N., 20°14' W., — 80 —
 Greenland: Davis Strait, — 100 fathoms (without further details)
 Iceland: 5 miles E. of Seydisfjord, — 185 —
 Ingolfshöfði 9½ miles N. by E. 1/3 E. (depth not stated)
 Vestmanö, depth 50 fathoms
 Skagi, — 40 metres
 6 miles W. of Iceland (without further details) [labelled *Diphasia rosacca*]
 Önundarfjord, depth 10 fathoms [— — —]
 65°39' N., 28°25' W., depth 553 fathoms.
 Between Iceland and The Faroe Islands: depth 270 fathoms (without further details).
 The Faroe Islands: 8—10 miles N. of The Faroe Islands (— — —)
 7 miles N. by E. of Myggenæs point, depth 57 fathoms
 6 — N. by W. of Store Kalsö, — 60 —
 Deep hole at north point of Nolsö, — 100 —
 Borönæs 13 miles in N. 75° W. — 30 —
 16 miles E. by S. of south point of Nolsö — 80 —

It may be a question whether *Diphasia fallax* cannot exceptionally be confused with *Diphasia Wandeli* Levinsen, if the latter species, as Sæmundsson opines, can occur with only two rows of hydrothecæ on the branches. There are also in the present material colonies of *Diphasia fallax* differing in appearance, so that there is some ground for further considering the point.

Sæmundsson (1911 p. 97) mentions having found colonies of *Diphasia Wandeli* with only two rows of hydrothecæ on the branches, and with female gonothecæ, which, however, from his drawings, agree entirely with *Diphasia fallax*. According to a footnote in Sæmundsson's work (1911 p. 98) Levinsen should, after seeing the colonies, have expressed as his opinion that they must rather be regarded as aberrant colonies of *Diphasia fallax* than as representatives of *Diphasia Wandeli*. Now Sæmundsson points out, in the same place, that a colony of *Diphasia Wandeli* from the Norwegian Sea, which he has had occasion to study, had on the basal parts of eight of its branches only two rows of hydrothecæ, while the outer parts of these branches, and all the remaining ones throughout their length, had three rows of hydrothecæ. This reminds one not a little of the aberrant *Thujaria*, which is further described in "Fauna artica" (Broch 1909 p. 177). As the colony described by Sæmundsson is sterile, it cannot be determined with certainty. It is probably a *Diphasia Wandeli*, but it might also be imagined that it could be a mutant of *Diphasia fallax*, though this is less likely to be the case. Typical female colonies of *Diphasia Wandeli* with gonothecæ have not yet been found; as to the males, we know that they differ from *Diphasia fallax* in having eight instead of four distal spines on the gonothecæ, these eight spines being arranged in pairs. It is therefore impossible to say with certainty which species Sæmundsson had before him, as long as typical and fertile female colonies of *Diphasia Wandeli* have not yet been found. Sæmundsson's colonies form, moreover, only the extreme link in a continuous variation series, of which the central one is *Diphasia fallax*.

The "Ingolf" brought back from several of its stations colonies of the same type described by Sæmundsson as *Diphasia Wandeli*. They are stiffly built, with a distinctly marked, often somewhat darker and plainly segmented main stem. Each internodium has a pair of hydrothecæ and a branch, directed alternately to either side, so that in these colonies, we have constantly two hydrothecæ between two successive branches on the same side of the stem; of these two hydrothecæ, the one (the lower) is situated in the corner by the branch. In the most extreme specimens of this variant group, we find single undivided branches. This variety is represented by a particularly pure type in specimens from the "Ingolf" St. 3 and St. 93. In these colonies, there is no pronounced fore or rear side as generally seen in *Diphasia fallax*. This must doubtless be taken in connection with the fact that the

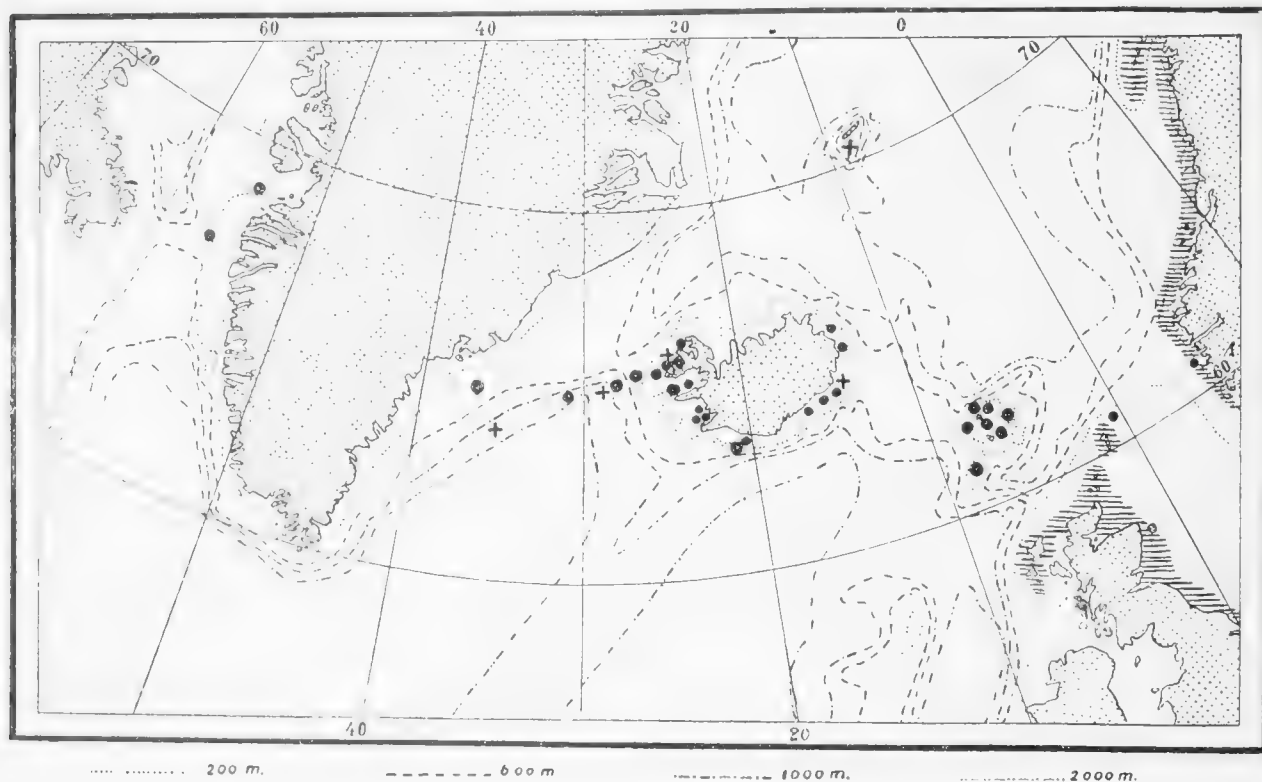


Fig. LIX. The distribution of *Diphasia fallax* in the Northern Atlantic.

In the hatched regions a common occurrence in reported (+ the variety spoken of in the text).

most marked representatives of the variety are attached to a firm underlayer, stones or mollusc shells, and not, as is mostly the case with this species, to stems of other hydroids; they thus stand more perpendicularly, and consequently develop more symmetrically, whereas the ordinary colonies, being fixed in a more horizontal position, find it better to develop more onesidedly, with an upturned "front".

Among the numerous transition forms, it will here suffice to mention some specimens from "Thor" (65°52' N., 23°58' W.). They are very closely allied to the group of variants described as a distinct variety, but exhibit at the same time several of the characteristic features of the main species. The stem is not quite so marked as compared with the branches, albeit its darker brown colour helps to bring it out; its segmentation is less prominent, and the branches proceed more openly and somewhat irregularly, with three, or more often four hydrothecæ between two branches on the same side

of the stem, the one hydrotheca in the branch corner. Finally, the branches and the colonies are curved, so as to present a distinctly convex foreside; the branches themselves also, are not infrequently again ramified. The colonies are thus typical transition forms, and as such occur in all shades of difference between the typical main form and the extreme, regularly pinnate variants, we cannot separate the latter as a distinct species.

Kramp (1914 p. 1053) has very appropriately characterised *Diphasia fallax* as "an atlantic boreal species only sporadically found in arctic regions". Its occurrence in the north Atlantic (fig. LIX) shows, however, that it is still not quite universal in the boreal waters; it appears, strangely enough, to be very rare off the west coast of Greenland, where we should otherwise have expected to find it of common occurrence in the mixed company of southern and northern forms found in Davis Strait. Bathymetrically, its chief occurrence falls in the middle and lower part of the littoral region, and the upper part of the abyssal; at times it may penetrate far down into the latter, as is shown by the list of finds from the "Ingolf". It is consequently the more remarkable that *Diphasia fallax* should seem to disappear at a somewhat greater distance from the coasts. A glance at the chart shows that the species has very rarely indeed been taken far from islands or continent, and this cannot be accidental, since the investigations both of the "Ingolf" and later expeditions have been carried out to a very great extent in the open sea within the areas in question. The explanation of this must be left to future studies.

***Diphasia Wandeli* Levinsen.**

1893 *Diphasia Wandeli*, Levinsen, Meduser, Ctenophorer og Hydroider, p. 55, pl. 8, figs. 1—5.

Upright pinnate colonies with pronounced dark monosiphonic main stem. The stem is divided by transverse nodes into short internodia, each bearing a pair of hydrothecæ placed oppositely, and a branch under the base of the one, turning alternately to either side of the stem. The branches are likewise divided up into short internodia, each having three hydrothecæ in a wreath; there are thus three rows of hydrothecæ on each branch. The hydrothecæ are deeply embedded; the adcauline wall has a free distal part about one-fifth to one-fourth the length of the hydrotheca, between half and once the opening diameter. The opening is set almost perpendicular to the branch axis; the margin has a slight adcauline sinus, in which the large opercular plate is attached.

The gonothecæ arise on the branches close under the base of the hydrothecæ. The males are reversely conical, with eight short paired spines on the distal part; the narrow distally central aperture has a rudimentary neck, or none at all.

Material:

Greenland: Davis Strait 65°22' N., 54°02' W., depth 66 fathoms [Levinsen's type specimen].

Diphasia Wandeli appears to be a very rare species; typical three-rowed colonies have, besides the spot mentioned, only been found once, near Papey, East Iceland. All the other specimens recorded by Sæmundsson (1902 p. 67 and 1911 p. 97) belong properly to the above described variety of *Diphasia fallax*. The two finds belong to the middle part of the littoral region.

***Diphasia rosacea* (Linné) L. Agassiz.**

1758 *Sertularia rosacea*, Linné, Systema naturæ, Ed. 10, p. 807.

1862 *Diphasia rosacea*, L. Agassiz, Contributions to the natural history of the United States, vol. 4, p. 355.

Upright colonies without distinct main stem. The colonies are irregularly pinnate or bushily branched, segmented, and with a pair of oppositely placed hydrothecæ on each internodium. The hydrothecæ are slender, almost evenly tubular, with slightly divergent distal part. The free distal portion of the adcauline wall is about half the length of the hydrotheca, between $1\frac{1}{2}$ times and twice the opening diameter, rarely somewhat shorter, down to about the same length as the opening dia-

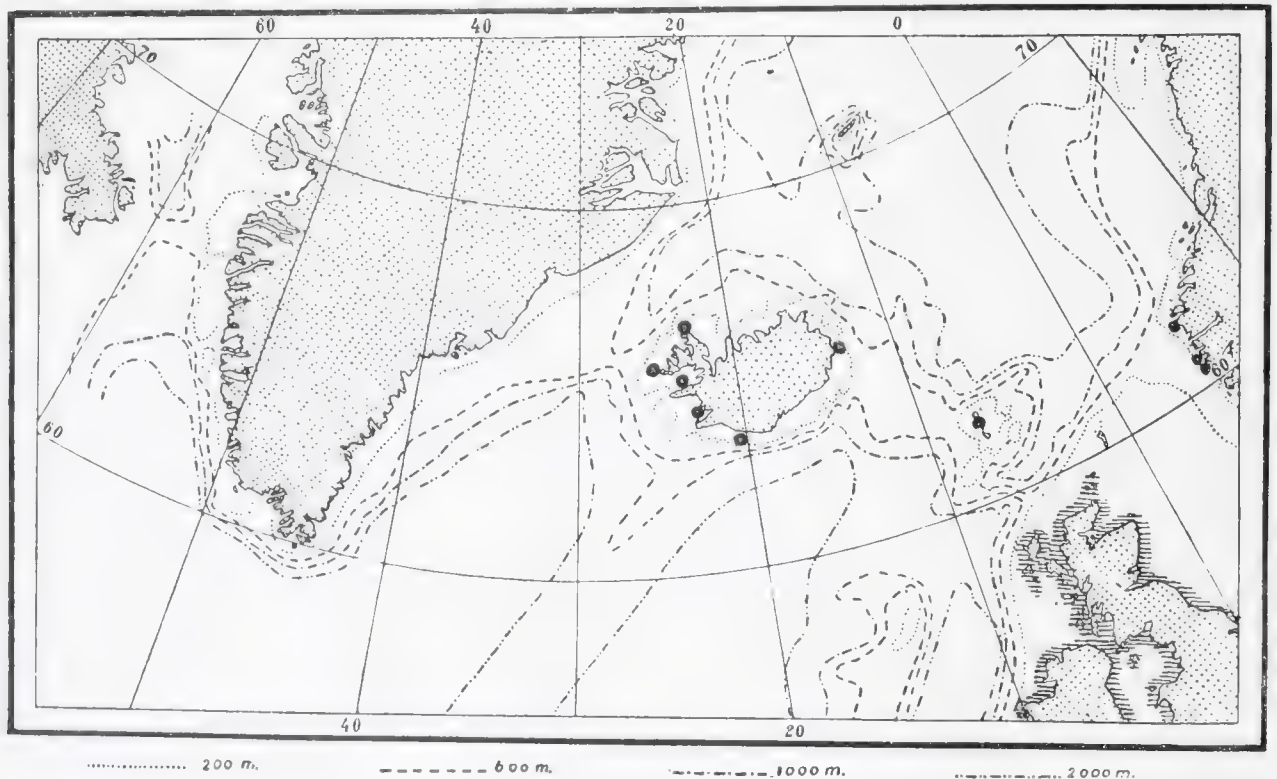


Fig. LX. The occurrence of *Diphasia rosacea* in the Northern Atlantic.

In the hatched region a common occurrence is recorded.

meter. The opening margin has a slight adcauline sinus, in which the large opercular plate is attached.

The gonothecæ arise close under the base of the hydrothecæ. The males are pear-shaped, with normally eight longitudinal ribs, each terminating in a distal short blunt point; the gonotheca has a central short cylindrical neck. The females are also pear-shaped, with eight long ribs, of which six terminate in as many broad blades closing together over a distal brood-chamber; the two last, diametrically opposite ribs end in forward pointing horn-like outgrowths of varying length.

Material:

"Thor" 63°30' N., 20°14' W., depth 80 metres.

Iceland: Stykkisholm, — 30 fathoms.

Sæmundsson (1902 p. 66) also mentions specimens of this species from Önundarfjörður, Iceland, but a reinvestigation of his specimens shows that they must be referred to *Diphasia fallax*.

Diphasia rosacea should doubtless be regarded as a southern species having a very wide distribution in the southern part of the boreal area (fig. LX). It has been found at several places near Iceland, and is also recorded from the Faroe Islands. Round the British Isles and in the North Sea it is very common, and very frequent between Bergen and Stat on the west coast of Norway. Having also been found in north Norway (Tananger), it will probably likewise prove to be fairly common along the Norwegian coast in the deeper part of the laminaria belt, which is its true home.

***Diphasia attenuata* Hincks.**

1866 *Sertularia attenuata*, Hincks, On new British Hydroida, p. 298.

1868 *Diphasia attenuata*, Hincks, A History of the British Hydroid Zoophytes, p. 247, pl. 49, fig. 1.

Upright, often brown-coloured, pinnate colonies with slightly pronounced monosiphonic stem, the lower part often without hydrothecæ or branches, and divided into internodia of irregular length; the upper part of the stem has alternating branches, which are in rare cases themselves secondarily branched to a slight degree, and may now and again terminate in tendril-like outgrowths. The branches and the upper part of the stem are indistinctly segmented; each internodium bears a pair of oppositely placed or slightly subalternating hydrothecæ. Between two successive branches on the same side of the stem, there are as a rule three, more rarely four hydrothecæ, the lowest in the branch corner. The hydrothecæ are large, tubular, the free distal part of the adcauline wall amounts to about half the length of the hydrotheca, and is somewhat more than the diameter of the opening. The hydrotheca is bent to an angle, so that its free part forms an angle of about 60° with the branch axis. The hydrotheca opening is nearly perpendicular to the branch axis; its margin has an adcauline sinus, in which the large opercular plate is fastened.

The gonothecæ are situate on the upper side of the branches, and proceed from close under the base of the hydrothecæ. The male gonothecæ are oval to pear-shaped, with six faint longitudinal ribs terminating distally in as many blunt points; the aperture is centrally placed on a broad distal cone. The female gonothecæ are oblong pear-shaped, and have likewise six faint longitudinal ribs, each with one or two markedly prominent spines on the distal part; the gonothecæ lack distal brood-chamber.

Material:

"Ingolf" St. 96,	65°24' N.,	29°00' W.,	depth 735 fathoms,	1,2°
— - 98,	65°38' N.,	26°27' W.,	— 138 —	5,9°
— - 115,	70°50' N.,	8°29' W.,	— 86 —	0,1°
— - 127,	66°33' N.,	20°05' W.,	— 44 —	5,6°

Diphasia attenuata belongs to the littoral region of the warm Atlantic, and penetrates at times even far down into the abyssal region; the species has previously been quite frequently observed in British waters. The finds at the threshold of Danmark Strait are therefore not surprising, but that from Jan Mayen is remarkable, and must doubtless be accounted for as due to larval transportation, possibly from the waters about Danmark Strait in the same way as the occurrence at the "Ingolf" St. 127 at the north side of Iceland.

Diphasia alata Hincks.

1855 *Sertularia alata*, Hincks, Notes on British Zoophytes, p. 127, pl. 2.

1868 *Diphasia alata*, Hincks, A History of the British Hydroid Zoophytes, p. 258, pl. 48, fig. 2.

Upright pinnate colonies with a not very marked, brown, monosiphonic stem, exceptionally polysiphonic in its basal part; the stem and branches are indistinctly segmented. The hydrothecæ are arranged in opposite or subalternate pairs; they may also, in exceptional cases, be alternately set. On the branches, the hydrothecæ exhibit a tendency towards unilateral arrangement on the front of the colony. The branches arise alternately from the stem; between two successive branches on the same side of the stem there are three hydrothecæ, the lowest at the branch corner. The hydrothecæ are large, bent to an angle, with a free distal portion of the adcauline wall between one-third and one-half the length of the hydrotheca, about equal to the opening diameter. The abcauline wall has at the middle, near the bend, a prominent transverse inner rib; the angle between the branch axis and that of the distal part of the hydrotheca is greater than 60° . The plane of the hydrotheca aperture is almost perpendicular to the branch axis; the margin has a deep adcauline sinus, in which the large opercular plate is attached.

The gonothecæ are small, almost pear-shaped, distally quadrilateral in section, with a short and blunt distal point in each corner, and a small round distally central opening, but no neck. The female gonothecæ develop no brood-chamber; they are as a rule slightly asymmetrical, whereas the males are symmetrical in structure.

Material:

"Thor" $35^\circ 57' N.$, $5^\circ 35' W.$, depth 740 metres.

Diphasia alata belongs to the warmer tracts of the eastern part of the Atlantic, and seems there to be mainly restricted to the lower part of the littoral region and the upper portion of the abyssal. It is a rare visitor in the northern waters, where it has been observed off the west coast of Scotland, at the Hebrides, Shetland, and the west coast of Norway from Jæren to a little north of Bergen. It has not, however, been recorded from the Faroe Islands, Iceland or Greenland.

Gen. *Dynamena* (Lamouroux).

Upright colonies with imbedded, bilaterally built hydrothecæ. The hydrotheca aperture has two large lateral teeth, between which there is a large abcauline sinus and a smaller adcauline one; the latter is often divided into two by a slightly prominent median tooth. In each main sinus a membrane is fixed, so that the closing apparatus consists of two membranes, the abcauline with a free distal part. The polyp has no pronounced blind sack.

This definition of the genus *Dynamena* we also find indicated by Kühn (1913 p. 252). Levinsen is not disposed to consider the development of a pronounced blind sack as of any systematic importance (1913 p. 286), which view must doubtless be accounted for by his having apparently confused this feature in the organisation with casual S-shaped hydranth contractions. Kühn regards the

disappearance of the blind sack as a secondary phenomenon, and keeps mainly to the character of the gonangia. In this, however, it is impossible to concur, as these organisational features are entirely independent one of another, and the lines of development in gonangia and polyps can clearly not be taken as of equal significance. There is, as I have often here pointed out, no reason to reduce the importance of polyp development in systematics; phylogenetically, it is the most valuable clue. And in this case, it suggests that lid formation may partly indicate converging lines, as will be seen from the diagram given under the heading of *Sertulariida*. It is therefore likewise impossible to follow Levinsen in grouping *Dynamena* and *Sertularia* together in one genus exclusively from the uniformity of their closing apparatus.

***Dynamena pumila* (Linné) Lamouroux.**

1758 *Sertularia pumila*, Linné, *Systema naturæ*, Ed. 10. p. 807.

1812 *Dynamena pumila*, Lamouroux, *Extrait d'une mémoire sur la classification des Polypes*, p. 184.

Upright colonies with irregular, as a rule pinnate ramification, exceptionally with an indication of monosiphonic main stem. The branches are secondarily ramified in irregular pinnate formation. The colony is divided into short internodia, each bearing a pair of hydrothecæ oppositely placed. The hydrotheca is deeply embedded; its adcauline wall has a free distal portion about the same length as the opening diameter, between one-fourth and one-third the length of the hydrotheca. The opening margin has two prominent lateral teeth, and in the middle of the adcauline lesser sinus is a slightly developed broad median tooth. The adcauline closing membrane has no free part; the abcauline is large, with a free distal part. The diaphragm almost radially symmetrical.

The gonothecæ proceed from below the base of the hydrothecæ on the one side of the branches. They are pear-shaped, with a very short neck, and a round, symmetrically situate distal opening with operculum. Material:

Greenland: Egedesminde

Sukkertoppen

Julianehaab, on *Fucus*.

Kangerdluarsuanguak.

Iceland: Reykjavik, on *Ascophyllum*, and *Fucus*, and down to 4 fathoms depth.

Grindavik, Bredebugt

Grafarvogr

Isafjord.

The Faroe Islands: Strömö.

Thorshavn.

I have in a former work (Broch 1910 p. 29) pointed out that Nutting's drawing of the gonotheca (1904 p. 27, fig. 80) is altogether misleading, presenting the impression that the acrocyst, as it projects from the gonotheca, must perforate the operculum. This is, however, not the case; the operculum opens at one side, and the acrocyst is then thrust through the opening thus made.

Dynamena pumila belongs to the tidal zone, and is most frequently found on fucoids and the shallower living *Laminaria*; the species evinces a high degree of elasticity with regard to salinity,

and thus belongs to the hydroids found farthest up in the fjords, where the salinity is greatly reduced by the inflow of river water. The species has also a wide southerly distribution, and is very common even in the Mediterranean. It is a character form in the boreal areas (fig. LXI) where it occurs in quantities along the coasts. On the other hand, its occurrence in strictly arctic waters is very rare and sporadic. From Greenland it has been recorded at several places along the west coast, and will probably prove more frequent here than the data at present to hand would seem to show.

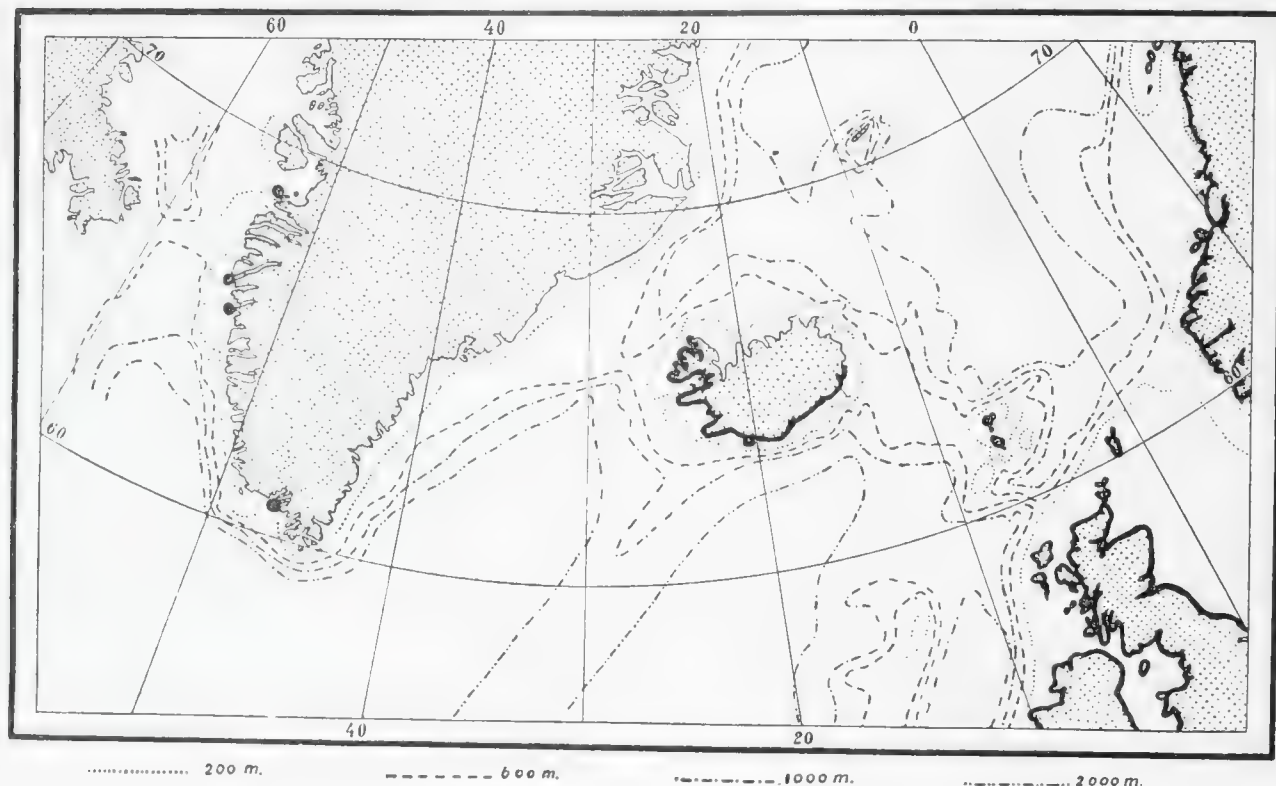


Fig. LXI. The distribution of *Dynamena pumila* in the Northern Atlantic.

Gen. *Abietinaria* (Kirchenpauer).

Upright colonies with hydrothecæ having their opening horizontally or slightly obliquely set; the opening margin lacks distinct teeth, but has often an adcauline sinus in which the large single opercular plate is fixed. The polyp has a well developed abcauline blind sack.

On comparing this definition with that given by Levinsen for the sub-genus *Abietinaria* (1913 p. 310) we at once find that there is a fundamental difference, the diagnosis here given being based chiefly on the organisation of the polyp. This gives us a clear mark of distinction as against *Diphasia*, and necessitates the separation of the groups as two different genera. There can be no doubt that *Diphasia*, as defined by Levinsen, formed a diphyletic group, and that two separate lines of development lead from the *Sertularella* to the two groups. The relation in point of opercular formation must here doubtless be taken as a secondary phenomenon of convergence, in comparison with the organisation of the polyp.

Abietinaria abietina (Linné) Kirchenpauer.

1758 *Sertularia abietina*, Linné, Systema naturæ, Ed. 10, p. 808.

1884 *Abietinaria abietina*, Kirchenpauer, Nordische Gattungen und Arten von Sertulariden, p. 29, 35.

Coarsely built, pinnate colonies, the branches often secondarily branched pinnately in the same plane. The stem is zigzag, with paired subalternating hydrothecæ in two rows, there are as a rule three, more rarely four hydrothecæ on the stem between two successive branches on the same side, the lowest in the branch angle. The hydrothecæ of the branches are set subalternately in pairs, and in two opposite rows. The hydrothecæ are large, swollen at the lower end, narrowing upwards and terminating in a short slightly outward curving neck; the aperture lies obliquely or more rarely perpendicular to the branch axis; the margin has no adcauline sinus; the opercular plate is attached adcaulinally. The free distal part of the adcauline wall is more than half the length of the hydrotheca, and about twice that of the opening diameter. The interval between two successive hydrothecæ on the same side is from half to once the length of the hydrotheca, rarely a little less. The diaphragm is of distinctly bilateral structure, with a narrow egg-shaped cleft, the longitudinal axis of which lies in the broad plane of the branch.

The gonothecæ proceed from close under the basis of the hydrothecæ, and are as a rule set on the upper side of the branch. They are oval, with a short, almost rudimentary stalk, and have a short, broad cylindrical neck.

Material:

"Thor" 65°52' N., 23°58' W., depth 62 metres

— 62 29.5' N., 24°56' W., — 40 —

— 64 16' N., 22°17' W., — 50 —

— 64°02' N., 22°33' W., — 34 —

— 63°30' N., 20°14' W., — 80 —

— 61°07' N., 9°30' W., — 835 —

Greenland: Store Hellefiskebanke, off Holstensborg, depth 18—20 fathoms.

Iceland: Bakkefjord (depth not stated)

Seydisfjord, depth 6 fathoms

Off Seydisfjord (depth not stated)

Reydarfjord, depth 50 fathoms

Ingolfshöfði 9½ miles in N. by E. ½ E. (depth not stated)

Vestmanö, depth 25 fathoms

Reykjavik (depth not stated)

Hvalfjord, depth 24 fathoms

Breðbugt, 64°45.8' N., 23°55.2' W., depth 30 fathoms

6 miles W. of Iceland, 65°00' N., 24°38' W., depth 22 fathoms

Patreksfjord, depth 7—25 fathoms

Axarfjord, — 18 —

The Faroe Islands: 8—10 miles N. of the Faroe Islands (without further details)

6 miles N. by W. of Store Kalsö, depth 60 fathoms

7 — N. by E. of Myggenæs point — 57 —

Borönæs $1\frac{3}{4}$ miles in N. 75° W. — 30 —

Deep hole at north point of Nolsö — 100 —

13 miles W. by S. of Munken — 150 —

I have in earlier works (1908, 1909) united this species with the next, the more finely built form *Abietinaria filicula* (Ellis et Solander), having overlooked the specific character which lies in the

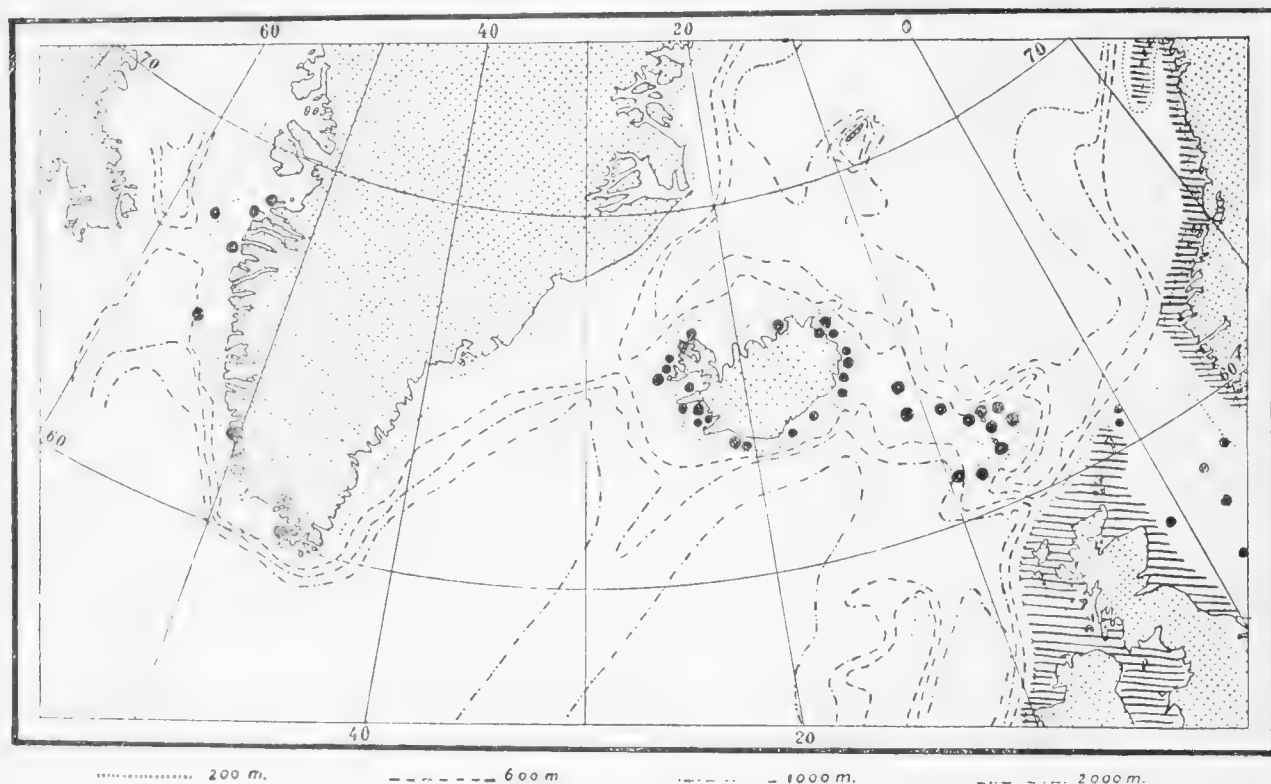


Fig. LXII. The distribution of *Abietinaria abietina* in the Northern Atlantic.

In the hatched regions a common occurrence is reported.

peculiar diaphragm of *Abietinaria abietina*, as pointed out by Levinsen (1893 p. 56). Generally speaking, the robust structure of the colonies will obviate any doubt when dealing with the last-named species, but this is not always the case. Occasionally, *Abietinaria abietina* may assume a finer structure (cf. Broch 1908) and it was from observation of such doubtful colonies that I was led to combine the two species under a common name. In such dwarf colonies, however, identity may easily be determined by examination of the diaphragm, which in *Abietinaria abietina* is typically bilateral, whereas in *Abietinaria filicula* the development is almost entirely radially symmetrical.

Abietinaria abietina is a circumpolar boreal species, capable of penetrating far into the arctic area, albeit its occurrence there is more sporadic. It can also move far to the south, and is found in the Mediterranean and at Madeira. It belongs really to the littoral region, but may exceptionally

penetrate down into the abyssal. In northern waters (fig. LXII) it is extremely frequent along the coast of Norway, round the British Isles, at the Faroe Islands and along the east, south and west coasts of Iceland but very rare on the north coast of the same. Along the east coast of Greenland it does not appear to have been found, but it is met with again from several parts of West Greenland. It is remarkable that it should not be represented in the large amount of material collected by the "Ingolf" expedition, but the explanation must presumably be that the species does not often live far from the coasts.

***Abietinaria filicula* (Ellis et Solander) Kirchenpauer.**

1786 *Sertularia filicula*, Ellis and Solander, The natural history of many curious and uncommon Zoophytes, p. 57, pl. 6, figs. c, C.

1884 *Abietinaria filicula*, Kirchenpauer, Nordische Gattungen und Arten von Sertulariden, p. 29.

Finely built pinnate colonies, the branches often secondarily ramified pinnately in the same plane as the main colony. Stem zigzag, with paired subalternating hydrothecæ in two opposite rows. There are as a rule three, more rarely four hydrothecæ between two successive branches on the same side of the stem, the lowest in the branch angle. The hydrothecæ of the branches also are arranged subalternately in two rows. The hydrothecæ have a swollen basal part, narrowing upwards, and with a slightly expanded opening margin; the opening plane is almost perpendicular to the branch axis. The opening margin lacks adcauline sinus, and has a large adcaulinally fastened opercular plate. The free distal part of the adcauline wall about half as long as the hydrotheca, and twice the opening diameter. The distance between two successive hydrothecæ on the same side is about equal to the length of the hydrotheca. The diaphragm is almost radially symmetrical, with circular aperture.

The gonothecæ arise close under the base of the hydrothecæ, and are as a rule set on the upper side of the branches. They are oval, with rudimentary stalk, and have a broad, short cylindrical neck.

Material:

"Thor"	65°52' N., 23°58' W.,	depth 62 metres
—	64°02' N., 22°33' W.,	— 34 —
Greenland, on ascidiæ (without further details).		
Iceland:	Bakkefjord,	depth 25—32 fathoms
	Seydisfjord,	— 6—38
	Reydarfjord,	— 50 —
	Faskrudsfjord,	— 20—50 —
	Breidalsvik,	— 14 —
	Djupivogr,	— 8 —
	Vestmanö,	— 10—15 —
	Faxebugt,	— 25 —
	Stykkisholm	— 30 —
	Skálanes,	— 7—8 —

Iceland: 6 miles W. of Iceland, $65^{\circ}32'$ N., $24^{\circ}38'$ W., depth 25 fathoms

Patreksfjord, depth 15–50 metres

Dyrafjord, (depth not stated)

Adalvik, (— - —)

The Faroe Islands: $61^{\circ}07'$ N., $9^{\circ}30'$ W., depth 410 fathoms

6 miles N. by W. of Store Kalsö, depth 60 fathoms.

Abietinaria flicula is a boreal species, rarely penetrating into arctic waters, nor does it enter the warmer seas; its distribution is circumpolar. Within the area investigated (fig. LXIII) it is frequent

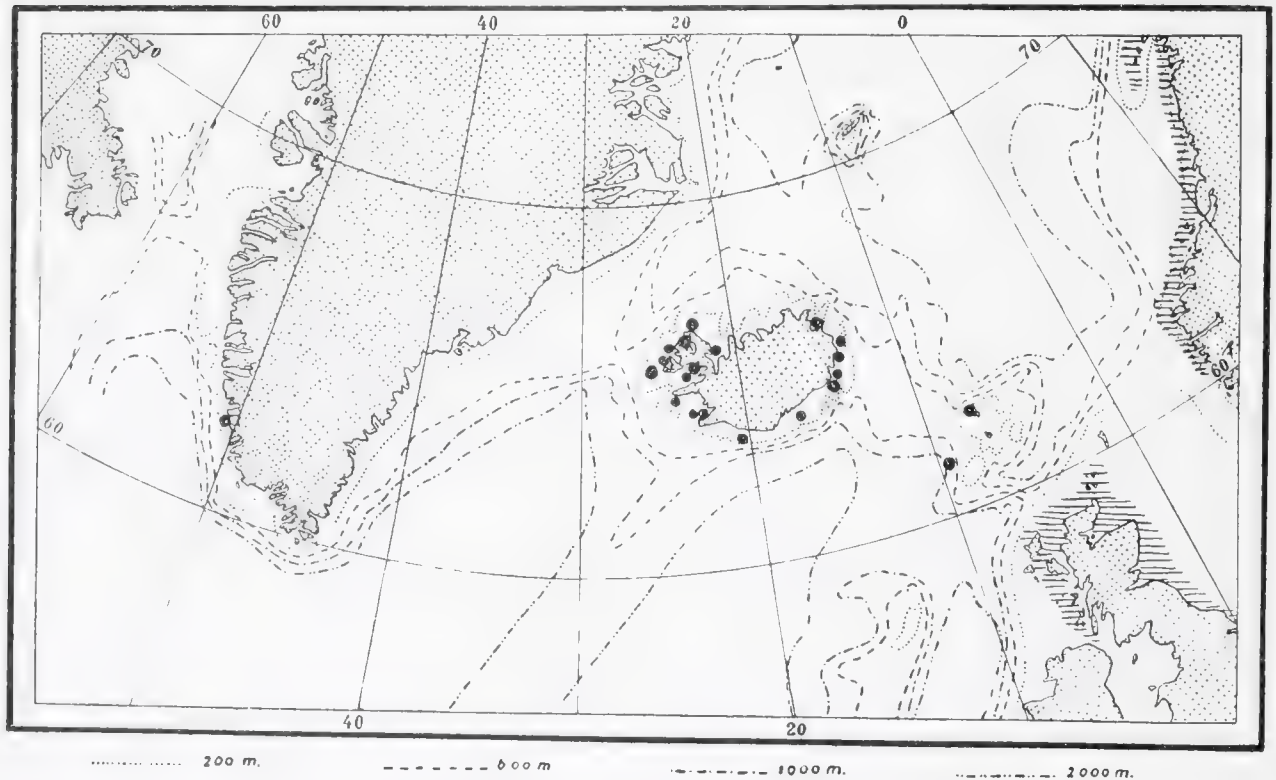


Fig. LXIII. The distribution of *Abietinaria flicula* in the Northern Atlantic.

In the hatched regions the literature notes a common occurrence.

off the west coast of Norway, and in the northern British waters; at the Faroe Islands it seems to be rare, while on the other hand it is one of the commonest species in Iceland waters, albeit lacking here along the north coast. About Greenland, *Abietinaria flicula* is very rare, and has only been recorded with certainty once from the west coast, near Godthaab. It belongs to the littoral region, but can quite exceptionally also move down into the abyssal, as for instance west of the Faroe Islands.

Abietinaria (?) *fusca* (Johnston) Levinsen.

1847 *Sertularia fusca*, Johnston, A history of the British Zoophytes, p. 70, fig. 11.

1874 *Thujaria salicornia*, Allmann, Report on the Hydroida Porcupine, p. 473, pl. 65, fig. 3.

1878 *Selaginopsis fusca*, Mereschowsky, New Hydroida from Ochotsk, Kamtschatka p. 436.

913 *Abietinaria fusca*, Levinsen, Systematic Studies on the Sertulariidae, p. 310.

Stiffly built, pinnate, dark-brown colonies with undivided branches. The stem, which is monosiphonic, is divided up into irregular internodia, and has two single longitudinal rows of hydrothecæ and two rows of alternating branches; there are three hydrothecæ between two successive branches on same side of the stem, the lowest in the branch corner. The branches have two rows of very closely packed hydrothecæ, the hydrothecæ in the single longitudinal rows have their oral parts alternately turned to either side, making a distinct approach to quadriserial arrangement, and the branches thus become almost quadrilateral in section. The hydrothecæ are small, entirely embedded, without any free distal part of the adcauline wall; the opening margin forms an adcauline sinus, in which the large opercular plate is attached. The hydrotheca opening is comparatively very large.

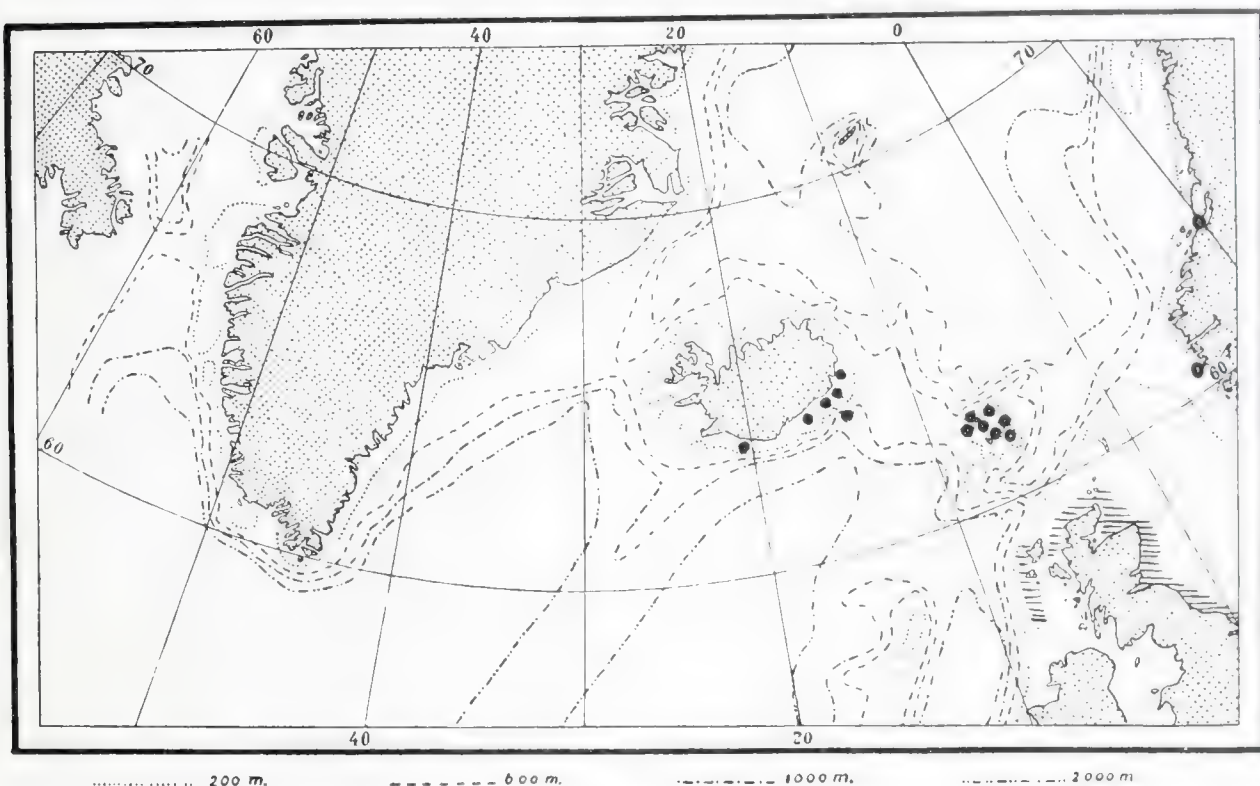


Fig. LXIV. The occurrence of *Abietinaria (?) fusca* in the Northern Atlantic.
(In British waters the data are somewhat vague, but note a rather common occurrence).

The gonothecæ are set on the upper side of the branches. They are pear-shaped, with short stalks.

Material:

- "Ingolf" St. 55 63°33' N., 15°02' W.; depth 316 fathoms, 5,9°
 The Faroe Islands: 7 miles N. by E. of Myggenæs point, depth 57 fathoms
 6 — N. by W. of Store Kalsö, — 60
 Deep hole at north point of Nolsö, — 100
 16 miles E. by S. of south point of Nolsö, — 80

It is uncertain whether this species can be allowed to retain its place in the genus *Abietinaria*.

Unfortunately, the state of the material did not permit investigation of the structure of the polyp, as to whether a blind sack has been developed or not; a query is therefore here appended to the generic name.

The geographical data for *Abietinaria*(?)*fusca* (fig. LXIV) present a somewhat scattered impression of an atlantic species not penetrating far into the boreal waters. On the other hand, its marked local restriction is highly surprising; the entire area of distribution of the species, or very nearly so, is shown in the chart. Outside the areas marked, *Abietinaria*(?)*fusca* has hitherto been recorded from the east coast of England and from Bohuslän (Sweden), as also, strangely enough, in a single instance from the Kola Peninsula (Jäderholm 1909 p. 95). Once also — "Ingolf" St. 55 — the species has been met with in the upper part of the abyssal region; otherwise, it has only been taken in the lower part of the littoral.

Gen. *Sertularia* (Linné).

Upright colonies with embedded, bilateral hydrothecæ, the opening with two large lateral teeth, between which is a large abcauline and a smaller adcauline sinus; the latter may be divided into two by a slightly prominent low median tooth. In each of the two main sinuses there is fastened a closing membrane, so that the closing apparatus consists of a smaller adcauline membrane without free part, and a larger abcauline membrane with free distal part. The polyp has a well developed abcauline blind sack.

The organisation of the polyp warrants the distinction here made between *Sertularia* and *Dynamena*. The genus *Sertularia*, as here laid down, forms a well-defined whole; the separation of the different *Sertularia* species, however, is an extremely difficult matter, and it is important first of all to take a survey of the various characters and their significance, in order to form an opinion as to the value of the species described from northern waters. In Jäderholm's arrangement (1909 p. 25) we find under *Thujaria* the following *Sertularia* species: *Sertularia Fabricii* Levinsen, *Sertularia robusta* Clark, *Sertularia plumosa* Clark, *Sertularia vegæ* Thompson, *Sertularia argentea* Linné, *Sertularia cupressina* Linné, *Sertularia inflata* Schydlofsky, *Sertularia Tolli* (Jäderholm), *Sertularia Thompsoni* Schydlofsky, *Sertularia tenera* G. O. Sars, *Sertularia arctica* Allman, and *Sertularia Birulae* Schydlofsky; to this must be added the polyserial *Sertularia mirabilis* Verrill. There is no doubt that the number of species must, on further investigation, be very considerably reduced. An examination of the variations which may occur within a single large colony will suffice to convince an unbiassed investigator that quite a number of the specific characters employed must be ranked among the more or less accidental variations, while other characters again properly belong to the category of developmental stages. It has not proved possible to procure indubitable specimens of all the 13 species mentioned, but I am inclined to ascribe this in part to their lack of solidity.

I have already in a previous work (1909 p. 171) pointed out that of the above-named species, *Sertularia arctica* and *Sertularia Thompsoni* are undoubtedly synonymous with *Sertularia tenera*. Jäderholm's drawings (1909 pl. 9, figs. 7—9) clearly show that *Sertularia vegæ* is synonymous with *Sertularia robusta*, to which species *Sertularia plumosa* should also probably be referred. We have

thus brought down the number of species to 8 or 9, which figure, as will be seen from the following, must be yet further reduced. Before passing on to special treatment of the different species, however, certain remarks as to the nature of the variations will not be out of place.

The form of the colony in all young *Sertularia* specimens is pinnate, and with the exception of a very few species such as for instance *Sertularia mirabilis*, it appears to be a general rule that the stem sooner or later assumes a spiral coil, while at the same time the broad plane of the branches changes from the perpendicular to the horizontal, perpendicular to the axis of the stem. The cause of this spiral coiling it is difficult to determine, but the feature itself cannot be accepted as a good specific character (cf. Broch 1912 p. 13). More importance should be attached to the winding of the coil, whether right or left; the only northern species which is dextrorse is the *Sertularia Fabricii*.

A peculiarity in all spirally coiled species is the fact that their branches are more or less markedly dichotomically ramified; as long as the colony still preserves its pinnate shape, this secondary ramification is less pronounced, but in spirally coiled forms it is more so.

The stem may be more or less prominent in one and the same species, now darker, now lighter in hue, as a rule slightly zigzag, more rarely quite straight, though this cannot be taken as a specific character. The distance between the branches proceeding from the stem likewise varies within one and the same species, and this feature has considerable influence on the habitus of the colony generally. The stem is in all species segmented; in those investigated, the internodia had as a rule one, more rarely two, and in quite exceptional cases three branches; where only one branch is present, it proceeds from the basal part of the internodium. It is not altogether impossible that the frequency of branches from the internodia may prove of some value as a specific character.

The hydrothecæ are subject to considerable variation within one and the same species. The divergent free distal part may diverge more or less from the branch, and it is somewhat different in the pinnate and spiral parts of the colony. In the pinnate portions, the symmetrical plane of the hydrotheca always coincides with the broad plane of the branch; in the spirally coiled part, on the other hand, we find that the hydrothecæ in most of the species tend more or less towards unilateral arrangement on the upward side of the branch. The aperture, however, varies very little indeed, and Nutting's statement (1904 p. 70) as to great variation in the character of the aperture in *Sertularia tenera* can only be ascribed to insufficient care in the investigation. Owing to this tendency to unilateral arrangement, we normally find that the hydrothecæ on these branches are seen in oblique projection. This has led numerous investigators to regard certain species, such as in particular *Sertularia argentea*, as furnished with asymmetrically developed lateral teeth, whereas careful investigation shows that this is not the case. — The proportion between length of the hydrotheca and the free projecting part seems to furnish a useful specific character.

The gonothecæ are, as already pointed out (1909 p. 172) extremely variable in *Sertularia* species, and their developmental stages have more than once been used as specific characters. It is simply astonishing to see how far from critical the investigations have often been with regard to this. The grown gonothecæ vary greatly in one and the same species. In species where they have no spines, they may be round in section, or angular, with a varying number of angles; this is also noted by Jäderholm (1909 p. 94) but he has not noticed that one colony may have both round and angular

gonothecæ at the same time. This character should therefore be used with caution. In species where the gonothecæ are furnished with spines, the development of the spines themselves often varies greatly in gonothecæ which are fully developed and bear acrocysts; their number also is subject to accidental variation in a striking degree. All this calls for discretion in using the gonothecæ as specific characters.

The variational phenomena here mentioned show, that careful and critical judgement is necessary in defining *Sertularia* species, at the same time indicating that many of the species already established have little justification for their position as such. The present material does not include all northern species, and cannot serve as a basis for thorough revision; it will nevertheless contribute to the elucidation of certain synonyms.

Sertularia cupressina Linné.

1758 *Sertularia cupressina*, Linné, Systema naturæ, Ed. 10, p. 808.

1758 *Sertularia argentea*, Linné, Systema naturæ, Ed. 10, p. 809.

Upright colonies, the young ones, and the basal parts of the larger ones, to a greater or lesser extent pinnate, with alternating or partly opposite branches. The older colonies have, for a shorter or greater distal part, sinistrorse spirally coiled stem, so that the branches stand in a spiral. The stem is as a rule distinctly prominent, monosiphonic, with a branch arising basally from the internodium; more rarely, the latter may have two, or quite exceptionally three branches. The branches themselves are secondarily more or less ramified dichotomically, their broad plane is in the pinnate parts perpendicular, in the spiral horizontal. Between two successive branches on the same side of the stem or in the same spiral there are two to four, as a rule three hydrothecæ, the lowest at the branch angle. The branches are divided up into irregular internodia with a varying number of hydrothecæ on each; the hydrothecæ are on the lower branches opposite, or subalternately placed, and have a common plane of symmetry with the branch; on the upper branches they are more or less turned upward towards the upper side of the branch; i. e. with a tendency to unilateral arrangement. The depth to which they are embedded in the branch varies somewhat; the basal have a smaller, the distal a larger free distal part. The adcauline wall has a free part from one-fourth to one-half the length of the hydrotheca; from one-third to a little more than the diameter of the aperture. The hydrotheca has its greatest breadth nearly at the middle, and narrows sharply towards the aperture, less markedly towards the base. The opening has two strong lateral teeth of equal size. The abcauline opercular plate has a large free distal part.

The gonothecæ proceed from the branches close under the base of the hydrothecæ, and on the upper branches they are always on the upper side. They are pear-shaped to slender oval, and oval in transverse section, distally provided with one or two lateral teeth in a highly variable stage of development; the teeth may also be entirely lacking. Distally, they narrow evenly down to a short, broad opening often surrounded by a short cylindrical neck.

Material:

"Thor" 65°52' N., 23°58' W., depth 62 metres

65°02' N., 13°56.5' W., — 140 —

- "Thor" 64°02' N., 22°33' W., depth 34 metres [labelled *Sertularia tenera*]
 — 63°30' N., 20°14' W., — 80 —
 Iceland: Bakkefjord, — 25—32 fathoms [labelled *Sertularia tenera*]
 Faskrudsford, — 20—50 —
 Vestmanö — 25 —
 Hvalfjord, — 22 — [some of the specimens labelled *Sertularia tenera*]
 The Faroe Islands: 6 miles N. by W. of Store Kalsö, depth 60 fathoms
 7 — N. by E. of Myggenæs point, — 54 —
 Vestmanhavn (depth not stated)
 Glyversnæs near Thorshavn (— - —)
 Deep hole at north point of Nolsö, depth 100 fathoms
 5 miles S.S.E. of Bispen, — 50 —
 North Sea: 3½ miles W. ¼ S. of Kærgaarde beacon, — 15 metres
 2 — N. by W. of Vedersö beacon, — 18—20 —
 East coast of Southern Jutland (without further details).

The study of the present extensive material of *Sertularia cupressina* has shown that variations have played a predominant part in the separation of *Sertularia* species. Hincks, in his classic work on the British Hydroids (1868 p. 271) draws distinction between *Sertularia argentea* and *Sertularia cupressina* on the lines that the former has a more bushy appearance, the latter a more "spire-like apex", while at the same time the dark stem of the latter species contrasts strongly against the lighter branches. In a large material, however, both these characters are seen to be subject to great variation, and in both respects the two species pass gradually over one into the other. The other distinctive feature is the hydrothecæ, which are thus described: "The hydrothecæ of the *cupressina* are appressed, tubular, not much narrowed or divergent above, with a bilabiate mouth, while those of *argentea* are shorter, swollen below, tapering upwards, with the aperture bent, sharply pointed at one side, and oblique". We need not here dwell on the general form; this is, as will be seen from the figures here given (fig. LXV) highly variable in one and the same branch. More weight should be attached to the fact that the opening in *Sertularia argentea* is oblique, i. e. furnished with one more and one less prominent tooth. Bonnevie (1899 p. 83) also, in her determinative key, attaches principal importance to this feature, whereas Nutting (1904 p. 62) less happily lays stress upon the remaining features in the hydrotheca. Further investigation, however, soon leads to the conviction that the character is based upon insufficiently careful study. Owing to the strong tendency of the species towards unilateral hydrotheca arrangement on the upper branches, the hydrothecæ will here be viewed in oblique projection (cf. fig. LXV). Consequently, the outer tooth is seen in its full length, the inner foreshortened in perspective. This is the cause of the oft-mentioned "asymmetry", which must consequently be abandoned as a purely fictitious character.

Both the mentioned species are noted in the literature as having the gonothecæ furnished distally with two lateral points, proceeding as outgrowths from the narrow margins of the gonotheca,

which is ellipsoidal in section. Even though this form may predominate in many colonies, it is nevertheless far from constant; a very high degree of variation may normally be observed even within a single colony (fig. LXV *c—k*). We often find, on one and the same branch, gonothecæ with two points, others with but one, and some with none at all. (This applies, of course, only to acrocyst-bearing, i.e. fully developed, gonothecæ; those shown were all provided with acrocysts.) Now while in some colonies the two-pointed gonothecæ are numerically predominant, though it is extremely seldom that they are practically supreme, this "normal" form of gonotheca is in the minority in other colonies, where on the contrary the great majority are of the one-pointed type; the entirely spineless

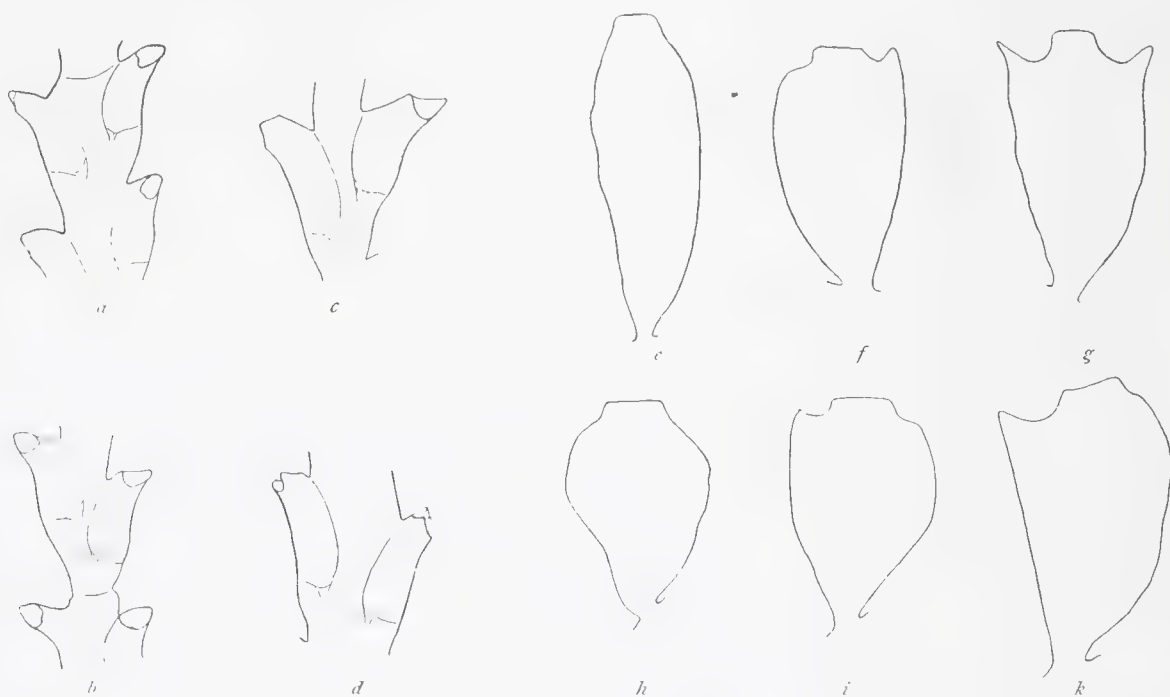


Fig. LXV. *Sertularia cupressina*.

a Distal hydrothecæ of a branch of a colony from the western coast of South Jutland. — *b* Proximal hydrothecæ from the same branch. — *c* Distal hydrothecæ of a branch of a colony from 6 miles N. by W. of Store Kalsö. — *d* Proximal hydrothecæ of the same branch. — *e—g* Gonothecæ from the same colony as *a* and *b*. — *h—k* Gonothecæ from the same colony as *c* and *d*. ($\times 40$).

gonotheca again is not represented to any considerable number in any colony in the material, and must be reckoned as an exception of more or less frequent occurrence. — The mentioned variations in the gonangia throw a doubtful light upon unicarinate forms such as *Sertularia Birulae* Schydlowsky, where the trophosome, according to the descriptions given, does not differ from that of *Sertularia cupressina*; the species should doubtless be withdrawn, but as it is not represented in the material, further investigation should be made before the point is decided.

After the investigations described, it is impossible to maintain the distinction between *Sertularia cupressina* and *Sertularia argentea*. The distinction in question, which was originally made from a very restricted material, has since only been retained on the strength of superficial studies, as is shown by the case of the asymmetrically developed teeth above mentioned. And it is just such superficial investigations which have led to this superfluity of species into which the genus is still divided.

Sertularia cupressina should best be characterised as a boreal species capable of penetrating

considerably into the arctic areas, and also southward into warmer seas; it is mentioned from the Mediterranean to Nova Zembla, but the most numerous finds have been made in the boreal region. The species is known from both sides of the Atlantic, and also from the Pacific, which renders its occurrence within the area investigated the more remarkable (fig. LXVI). It is very common in the British waters, and along the west coast of Norway, and is now found to be common also at the Faeroe Islands and on the east, south and west coasts of Iceland. It has not however, yet been recorded from Greenland, where there would seem every reason to expect it, since it is known from the arctic waters off the east coast of America. The reason of this peculiarity must for the present be left an open question. *Sertularia cupressina* has its chief occurrence in the upper half of the littoral region, and is only extremely rarely met with in the abyssal.

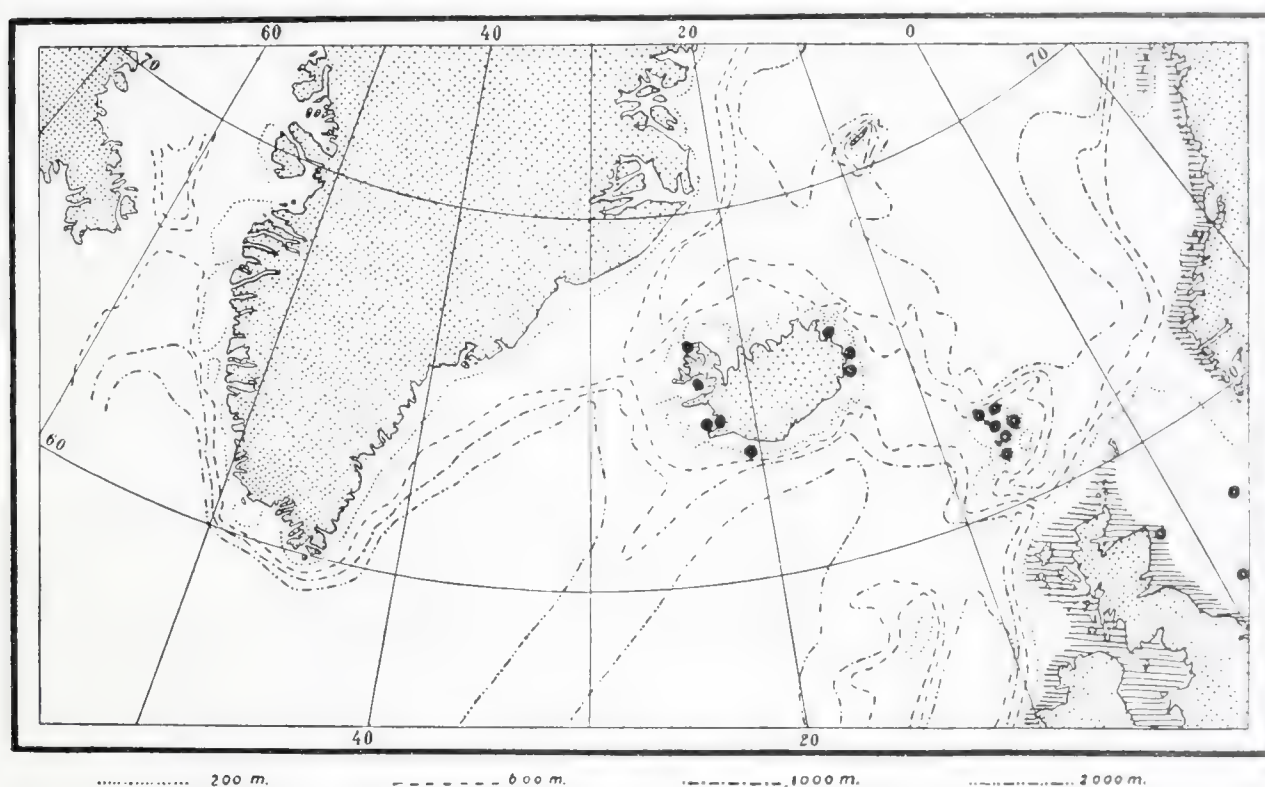


Fig. LXVI. The distribution of *Sertularia cupressina* in the Northern Atlantic.

In the hatched regions a common occurrence is stated.

Sertularia tenera G. O. Sars.

1874 *Sertularia tenera*, G. O. Sars, Bidrag til Kundskaben om Norges Hydroider, p. 108, pl. 4, figs. 1—4.

1874 *Sertularia arctica*, Allman, On the diagnosis of new genera and species of Hydroids, p. 179.

1884 *Sertularia albimaris*, Thompson, The Hydroid Zoophytes of the "Willem Barents", p. 3, pl. 1, 1—3.

nec 1877 *Sertularia albimaris*, Mereschowsky, On a new genus of Hydroids p. 228

1887 *Sertularia argentea* + *S. Diimphna*, Bergh, Goplepolyper (Hydroider) fra Kara-Havet, p. 335, pl. 28, fig. 3.

1899 *Dynamena unilateralis*, Bonnevie, Den norske Nordhavs-Expedition, p. 78, pl. 7, fig. 5.

1901 *Sertularia Thompsoni*, Schydlovsky, Les Hydroides de la Mer Blanche.

The young colonies are always pinnate, the larger ones now pinnate, now with distally sinistorse stem. The stem itself is but slightly pronounced, if at all; it is monosiphonic and indistinctly segmented, with almost regularly alternating branches. The branches again produce irregular, not infrequently alternating branchlets, which may further be tertially ramified. The pinnate portions of the colonies have the broad plane of the branches perpendicularly set; in the spirally coiled ones, on the other hand, it is horizontal. On the same side of the stem, or in the same spiral, there are three



Fig. LXVII. *Sertularia tenera*. Part of a branch with a polygonal gonotheca, from the Kara Sea, "Dijmphna". (X 40).

very rarely two or four hydrothecæ between two successive branches, the lowest in the branch corner. The branches are divided into irregular internodia with a varying number of hydrothecæ. The hydrothecæ are subalternately to alternately placed; their plane of symmetry coincides, in the pinnate portions, with the broad plane of the branches, but is often much displaced in the spiral parts, so that the hydrothecæ here often come very near to unilateral arrangement on the upper side of the branches. The hydrothecæ are not very deeply imbedded, and have a highly diverging distal part; the free distal part of the adcauline wall is almost invariably more than half the length of the hydrotheca, and twice to three times the opening diameter. The maximal breadth is near the middle decreasing thence equally to either end. The aperture margin has two distinct somewhat rounded lateral teeth of equal size; the abcauline large lid plate has a large free distal part.

The gonothecæ are attached to the branches close under the base of the hydrothecæ; in the spiral part always on the upper side of the branch. The gonothecæ are oval, and round or polygonal in section, in the latter case with four to six, most frequently five sides; they have distally a broad round opening and an often almost imperceptible tubulous neck.

Forma *spitzbergensis*: large, spiral and bushy colonies with approach to unilateral arrangement of the hydrothecæ.

Forma *sibirica*: large, pinnate, slender colonies with no indication of unilateral arrangement in the hydrothecæ.

Material:

"Ingolf" St. 69 62°40' N., 22°17' W., depth 589 fathoms 3,9°

"Thor" 64°16' N., 22°17' W., — 50 metres

Greenland: Egedesminde, on *Boltenia*, — 30—50 fathoms

Iceland: Hvalfjörð, — 22 —

The Faroe Islands: 2 miles N.W. of Agraaleide, depth 150 fathoms

Kara-Sea: "Dijmphna" [labelled *Sertularia argentea* and *Sertularia Dijmphnae*].

Sertularia tenera stands clearly apart from the foregoing species, and appears to vary somewhat less in the shape of the hydrothecæ. The two geographical varieties are peculiar; the only real distinction lies in the habitus of the colony, and it is not altogether rare to find transition forms, especially in the Murman Sea. We are still, however, unaware as to what factors exert the determining influence upon the shape of the colonies.

The principal difference, as compared with *Sertularia cupressina*, is apparent, even in quite young colonies, from the shape of the hydrothecæ. *Sertularia tenera* (fig. LXVII) has larger hydrothecæ than the mentioned species, and the highly divergent, quite large distal free part gives the colonies a peculiar appearance, very suggestive of *Abietinaria filicula* (Ellis et Solander) with which also its dimensions very nearly agree. A character applicable to the larger colonies on the whole is the fact that the main stem in *Sertularia tenera* does not exhibit any superiority in point of thickness over the branches, whereas in *Sertularia cupressina* it stands out in virtue of its greater dimensions; this feature, however, is not always absolutely reliable. — Despite their great variability, the gonothecæ also present certain differences as between the two species. The gonothecæ in *Sertularia*

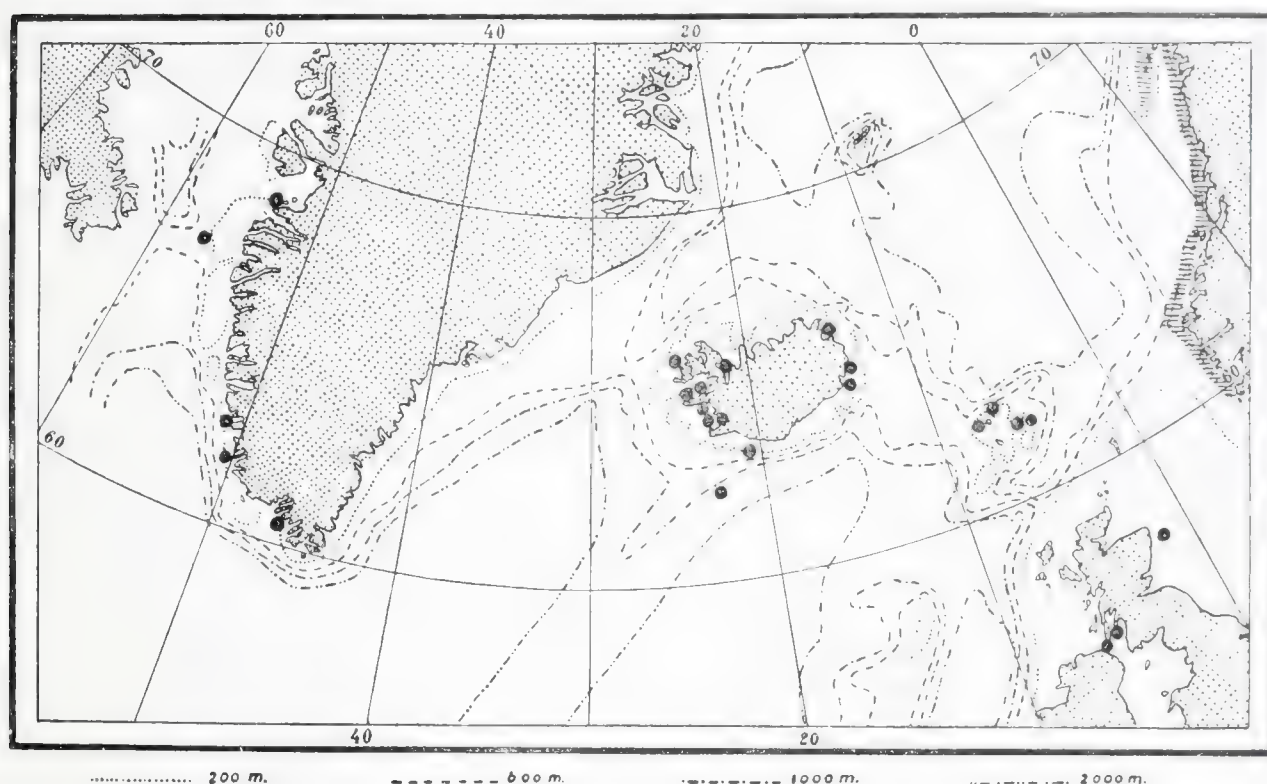


Fig. LXVIII. The distribution of *Sertularia tenera* in the Northern Atlantic.

In the hatched region a common occurrence is recorded.

tenera are, even where the polygonal form is markedly prominent, never furnished with spines, as is normally the case with *Sertularia cupressina*.

Jäderholm (1909 p. 94) suggests the possibility that *Dynamena unilateralis* Bonnevie (1899 p. 78) might be synonymous with *Thujaria arctica* (Allman). An investigation of the original specimens fully bears out the correctness of this supposition; the specimens are well developed and entirely typical colonies of *Sertularia tenera* forma *spitzbergensis*.

Sertularia tenera is an arctic-boreal species having its most frequent occurrence at the limit between the two areas; it belongs to the littoral region, and only exceptionally does it move down into the abyssal. The species has never before been met with at such a depth as at the "Ingolf" St. 69, and this find must be regarded as a mere accident. Ritchie (1911 p. 218) believes the species to

be more common in the Scottish waters than is generally supposed from the data obtained; he considers it likely that it may have been confused with young colonies of *Sertularia argentea*. This supposition will probably prove correct, as the species is fairly common along the west coast of Norway, and penetrates right down to Bohuslän. It is also not uncommon at the Faroe Islands and Iceland; with regard to the latter locality, it is scarce on the south coast, and apparently not very frequent on the north. From East Greenland, it is known only by a single find far to the north, whereas it has been met with several times in West Greenland waters. (Fig. LXVIII).

Sertularia Fabricii Levinsen.

1893 *Sertularia Fabricii*, Levinsen, Meduser, Ctenophorer og Hydroider, p. 48, pl. 6, figs. 14—17.

Upright colonies with not very pronounced, monosiphonic stem, the hydrothecæ and branches forming dextrorse spirals. Of the basal branches, only the basal internodium is retained, the remainder

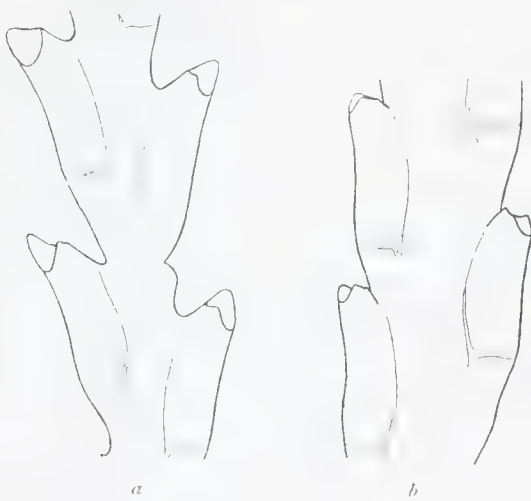


Fig. LXIX. *Sertularia Fabricii* from Godthaab.
 a Hydrothecæ from the distal part of a branch.
 b Hydrothecæ from the proximal internodium of the same. (× 40).

falling away. The stem is divided into internodia, each bearing a basal branch, alternating in each of the two hydrotheca series; between two successive branches in the same hydrotheca series the stem has normally three hydrothecæ the lowest in the branch corner. The broad plane of the branches is horizontally set. The branches are secondarily ramified dichotomically, and divided into internodia of varying length. The hydrothecæ are set in two rows, subalternately or alternately placed; they are deeply imbedded the free part of the adcauline wall is between one-third and one-sixth the length of the hydrotheca, or between one-half and one whole opening diameter. The distal part of the hydrotheca diverges only slightly from the axis of the branch. On the spiral branches, the hydrothecæ tend more or less towards unilateral arrangement on the upper side of the

branch. The hydrothecæ are of equal breadth in their imbedded part, and narrowing slightly in the free portion towards the opening; the margin of the latter has two short and broad lateral teeth; the abcauline opercular plate has a large free distal part.

The gonothecæ proceed from below the base of the hydrothecæ on the upper side of the branch. They are slender, reversely conical, somewhat flattened in transverse section, the narrow sides as a rule running out each into one short, strong tooth; more rarely, one tooth — or both — may be lacking. The gonotheca has a broad distal aperture, furnished with a short, often rudimentary cylindrical neck.

"Ingolf" St. 2,	63°04' N.,	9°22' W.,	depth 262 fathoms	5,3°
— - 3,	63°35' N.,	10°24' W.,	— 272 —	0,5°
— - 4,	64°07' N.,	11°12' W.,	— 237 —	2,5

Greenland: Store Hellefiskebanke, depth not stated	} Levinsen's type specimens.
Godthaab, depth 30—40 fathoms	
Julianehaab, depth not stated	

Jan Mayen, depth 50—60 fathoms (East-Greenland Expedition).

Iceland: Mouth of Berufjord, depth 41—54 fathoms.

Kara Sea, "Dijmphna".

Sertularia Fabricii is very closely related to *Sertularia cupressina*, but differs primarily in its dextrorse stem. Moreover, its hydrothecæ are as a rule more deeply imbedded than in the latter species (fig. LXIX). Levinsen (1893 p. 48) calls attention to a peculiarity in the species, to wit, that the basal branches throw off their extreme parts, leaving only the proximal internodium; this appears to be a characteristic feature in the species, the explanation of which cannot be arrived at from our present knowledge of its biology; it gives the species a highly remarkable appearance. Another char-

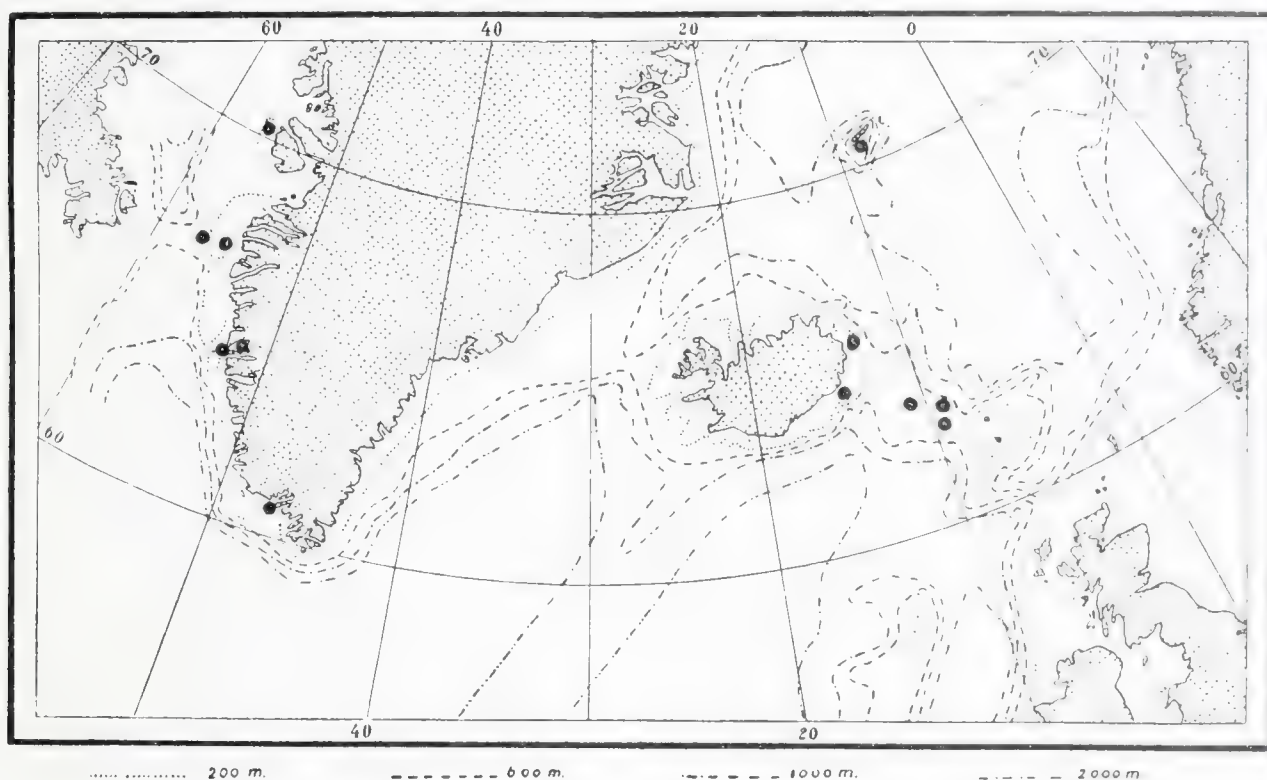


Fig. LXX. Finds of *Sertularia Fabricii* in the Northern Atlantic.

acter which has been emphasised is less reliable; according to Levinsen, the upright direction of the branches is 45° with the longitudinal axis of the stem; but the colonies from Jan Mayen and from the "Ingolf" St. 2 had branches standing out almost perpendicularly from the stem, and farther out even turning downwards; in these colonies also, the tendency to unilateral arrangement of the hydrothecæ is remarkably slight; despite this, and despite the fact that they are of finer build than those from Greenland, they cannot be regarded as types of a distinct species.

It is interesting to note how exactly the hydrothecæ in *Sertularia Fabricii* follow the same rules in their variation as in *Sertularia cupressina*. On the proximal part of the branches, the hydrothecæ are far more deeply imbedded than at the extremities (fig. LXIX). The gonothecæ, on the other hand, evince a much slighter variational tendency in the present specimens, which rather give

one the impression that only the extreme — and thus latest developed — gonothecæ on the branches can lack one or the other of the distal spines. This is different from what we find in *Sertularia curessina*, where the variants are distributed throughout the whole of the branch, without any distinctly demonstrable regularity. Nutting (1904 p. 71) who mentions the fact that the gonothecæ in *Sertularia Fabricii* do vary, has not gone into the question of detail.

The recent assignment of a previously undetermined specimen from the Kara Sea to *Sertularia Fabricii* suggests that we have here a circumpolar species, capable of penetrating somewhat down into the boreal areas. Further investigations will probably show the species to be more common in arctic waters than would appear from the data on record. *Sertularia Fabricii* doubtless belongs, strictly speaking, to the littoral region, but can, as shown by the finds at "Ingolf" St. 2, 3, and 4, also move some way down into the abyssal. The species has previously been recorded from Alaska and Puget Sound. Within the area investigated (fig. LXX) it is noted from West Greenland, Jan Mayen, and the submarine ridges between Iceland and the Faroe Islands, where the fauna is of a mixed character.

***Sertularia* (?) *tubuliformis* (Marktanner-Turneretscher) Levinsen.**

1890 *Dynamena tubuliformis*, Marktanner-Turneretscher, Die Hydroiden des k. k. naturhistorischen Hofmuseums, p. 238.

1904 *Thujaria tubuliformis*, Nutting, Sertulariidae, p. 70, pl. 11, figs. 1—8.

1913 *Sertularia tubuliformis*, Levinsen, Systematic Studies on the Sertulariidae, p. 298.

Upright pinnate colonies with alternating branches. The main stem has, on each internodium, on one side a branch and two hydrothecæ, on the other a hydrotheca. The branch has in most cases

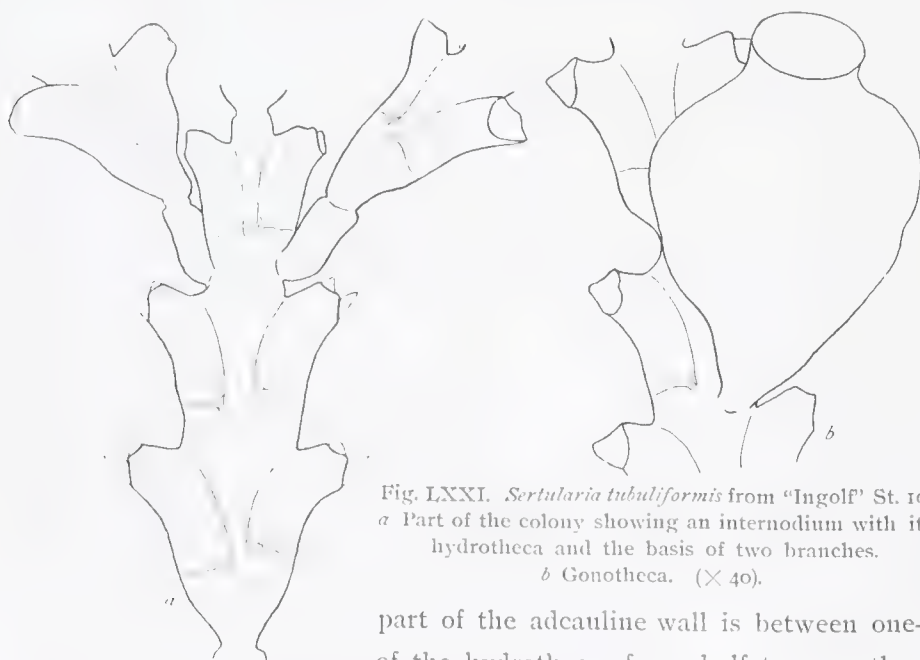


Fig. LXXI. *Sertularia tubuliformis* from "Ingolf" St. 10.
a Part of the colony showing an internodium with its hydrotheca and the basis of two branches.
b Gonotheca. (X 40).

minor branchlets oppositely placed, and is divided by distinct segmentation into internodia, bearing two to four, generally three pairs of hydrothecæ, of which the basal ones are the largest, the distal being the smallest. The internodium as a whole tapers distally. The hydrothecæ are set in more or less markedly subalternating, often almost opposite pairs, and are deeply imbedded. The free part of the adcauline wall is between one-third and one-fourth the length of the hydrotheca, from half to once the opening diameter. The hydrothecæ are of almost equal breadth throughout their length. The opening margin has two large lateral teeth, and a more or less strongly developed median tooth in the adcauline sinus. The closing apparatus consists of two membranes, of which the abcauline has a free distal part.

The gonothecæ proceed from close beneath the base of the hydrothecæ. They are flattened pear-shaped, with a broad opening on a distally central, trumpet-shaped neck.

Material:

"Ingolf" St. 10 64°24' N., 28°50' W., depth 788 fathoms, 3,5°.

In point of habitus, this little colony much resembles *Dynamena pumila*. Unfortunately, the state of preservation did not permit any further study of the polyps, and it is not impossible that the species may be found to lack the blind sack, in which case, of course, it must be referred to the genus *Dynamena*. There is no pronounced main stem, and the colony itself rather presents the impression of being only a branch. In all other features however (fig. LXXI) it entirely agrees with earlier descriptions, as also with colonies from West Africa, so that its specific identity is beyond doubt.

Levinson (1913 p. 298) notes that the median tooth in this species is of the same length as the lateral ones; this I have not found to be the case in any of the specimens I have been able to examine. The median tooth varies somewhat, and Levinson's statement seems to suggest that his material consisted of extreme variants.

The finding of this species in deep water so far to the north is highly interesting. In the Atlantic, it was formerly only known from West Africa, and from the tropic-subtropical littoral region of America to the region of Florida. It will probably also prove to inhabit other localities in the deep warm atlantic waters, when sufficient investigations have been made.

***Sertularia mirabilis* (Verrill) Levinson.**

1873 *Diphasia mirabilis*, Verrill, Brief contributions to Zoology, p. 9.

1893 *Sertularia mirabilis*, Levinson, Meduser, Ctenophorer og Hydroider, p. 49.

Upright, robust, pinnate, colonies. The main stem slightly zigzag, monosiphonic, and with two single rows of alternately set hydrothecæ. Between two successive branches on the same side of the stem there are three hydrothecæ, the lowest in the angle of the branch. The branches have six, more rarely only four longitudinal rows of hydrothecæ, the arrangement being produced as follows: three (or two) hydrothecæ are set in a wreath at the same height, and the next circle has its hydrothecæ facing the intervals of the first. The hydrothecæ are fairly deeply imbedded in the stem and branches, with a free part of the adcauline wall only about half the length of the hydrotheca, or between two and three diameters of the opening. The opening margin has two lateral, strongly prominent teeth and an almost rudimentary median tooth in the adcauline sinus. The abcauline closing membrane has a free distal part.

The gonothecæ proceed from close under the base of the hydrothecæ on the one side of the branches. They are pear-shaped to oval, smooth, with a rudimentary neck and broad round aperture.

Material:

"Thor" 61°07' N., 9°30' W., depth 835 metres

Greenland: Kudlisat, Disco (depth not stated)

Store Hellefiskebanke, depth 24—32 fathoms.

Iceland: Adalvig (depth not stated).

Kara Sea: "Dijmphna".

Sertularia mirabilis is a circumpolar arctic species, belonging to the upper and middle parts of the littoral region. This being the case, it is remarkable to find it, west of the Faroe Islands, in the abyssal region, as taken by the "Thor" (fig. LXXII). Within the waters investigated, *Sertularia mirabilis* is a species of rare occurrence, otherwise found once at the north-west point of Iceland, and high up in Davis Strait off the west coast of Greenland.

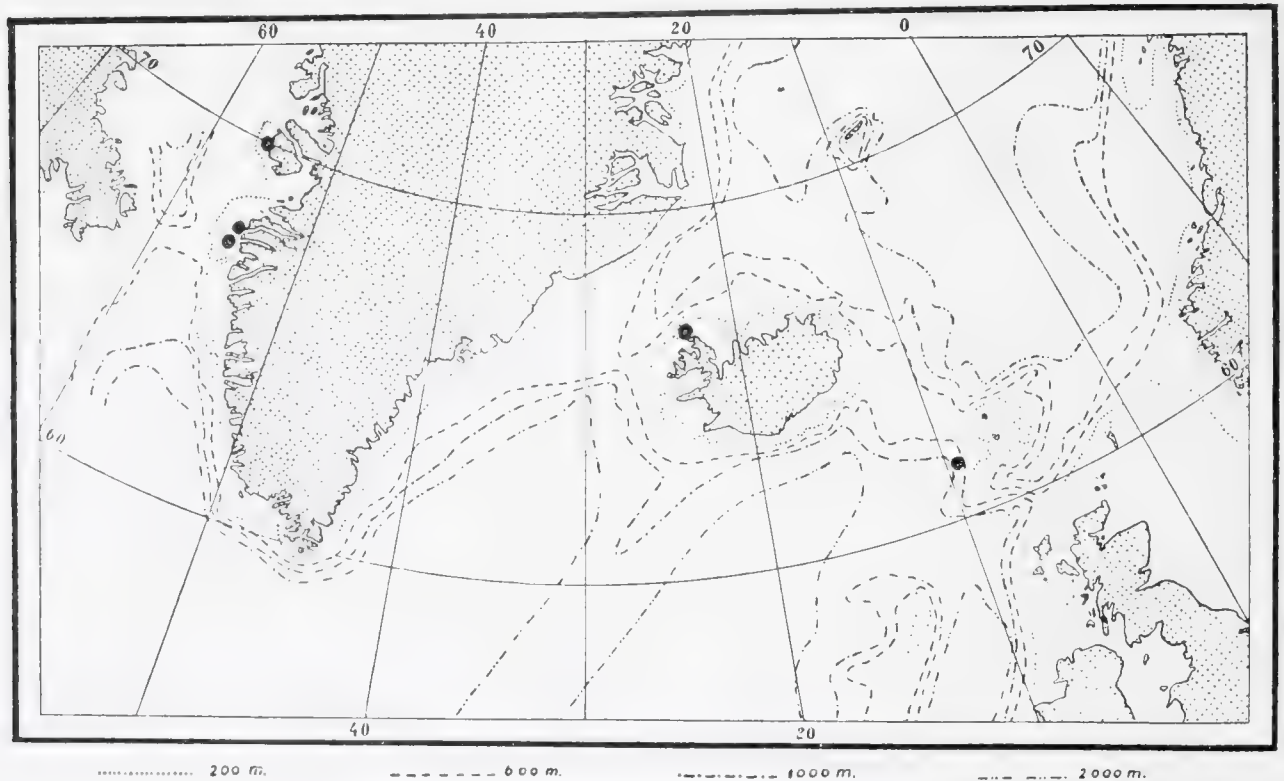


Fig. LXXII. Finds of *Sertularia mirabilis* in the Northern Atlantic.

Gen. *Hydrallmania* (Hincks).

Upright colonies with bilateral sessile to slightly imbedded hydrothecæ. The hydrotheca aperture is furnished with two lateral teeth, between which there is a smaller abcauline and a larger adcauline sinus; median teeth lacking. In each of the two sinuses there is fastened a membrane, so that the closing apparatus consists of two membranes, the adcauline with a free distal part. The polyp has a well developed abcauline blind sack.

The diagnosis as given coincides with Levinsen's definition (1913 p. 305); we have here merely added the structure of the polyp body. — Levinsen points out that it may be considered doubtful whether a separation between *Hydrallmania* and *Sertularia* really is altogether justified, and his observations noted in the following may to a certain degree serve to accentuate the dubiousness

of the point. In the northern *Sertularia* species, we find a general tendency towards spiral arrangement of the branches, together with an often very marked approach to unilateral arrangement of the hydrothecæ. The spirally placed branches are secondarily ramified, often dichotomically, but in *Sertularia tenera* irregularly pinnately. From this then, it is in reality but a short step to *Hydrallmania*. And finally, there is a certain amount of variation in the *Sertularia* species, with regard to proportion between the two sinuses, which in some species may be characterised as of equal size. We have thus, as the last and most essential distinctive feature, the fact that the adcauline closing membrane in *Hydrallmania* has a free distal part, whereas in *Sertularia*, this is reserved for the abcauline membrane. It may be doubtful whether these small differences should be regarded as of generic importance; for the present, however, I have found it most correct to follow Levensen in distinguishing between the two genera.

Hydrallmania falcata (Linné) Hincks.

1758 *Sertularia falcata*, Linné, *Systema naturæ*, Ed. 10, p. 810.

1868 *Hydrallmania falcata*, Hincks, *A History of the British Hydroid Zoophytes*, p. 273, pl. 58.

Colonies with slender, spiral, monosiphonic and segmented main stem, where as a rule each internodium bears a branch. The branches form an open spiral about the stem, and are themselves regularly secondarily ramified pinnately; the main stem has a hydrotheca in the corner at the origin of the branch, or may in rare cases be altogether devoid of hydrothecæ. Branches and branchlets are segmented, the irregular internodia bear on the one side (the upper) a more or less close row of hydrothecæ, the opening part of which is turned out alternately to either side from the median plane of the branch. On young pinnate colonies the hydrothecæ are imbedded, and alternately placed in two opposite rows on the branches, the broad plane of which stands vertically. The hydrothecæ are bottle-shaped to tubular, distally often bent, in young colonies with biserial arrangement, somewhat imbedded, in older ones with unilateral arrangement and almost sessile. The opening margin is armed with two large lateral teeth, the largest sinus is adcauline, and has a closing membrane with free distal part.

The gonothecæ are oval, as a rule somewhat flattened, with a short tubulous neck; they are quite smooth or irregular and slightly furrowed transversely.

Material:

"Ingolf" St.	6	63°43' N.,	14°34' W.,	depth	90 fathoms	7,0°
—	- 60	65°09' N.,	12°27' W.,	—	124	— 0,9°
—	- 87	65°02,3' N.,	23°56,2 W.,	—	110	— —
—	- 127	66°33' N.,	20°05' W.,	—	44	— 5,6°
"Thor"		66°19' N.,	23°27' W.,	—	115—120 metres	
—		65°52' N.,	23°58' W.,	—	62	—
—		64°16' N.,	22°17' W.,	—	50	—
—		64°06' N.,	23°14' W.,	—	98	—



Fig. LXXIII.
Hydrallmania falcata from the Trondhjem fjord. Part of a branch of a young, pinnate colony of the *Sertularia*-type. (× 40).

"Thor"	64°02' N., 22°33' W.,	depth 34 metres
—	63°30' N., 20°14' W.,	— 80 —
—	61°07' N., 9°30' W.,	— 835 —
Iceland:	Reydarfjord,	depth 45—80 fathoms
	Mouth of Berufjord,	— 41—54 —
	Vestmanö,	— 25—30 —
	Hvalfjord,	— 22 —
	Bredebugt, 64°45.8' N., 23°55.2' W.	depth 30 fathoms
	Stykkisholm,	— 30 —
	6 miles W. of Iceland, 65°32' N., 24°38' W.,	depth 22 fathoms
	Talknafjord,	depth 22 fathoms
	Dyrafjord,	— 15 —
	Önundarfjord	— 10 —
	Adalvik (depth not stated).	
The Faroe Islands:	6 miles N. by W. of Store Kalsö,	depth 60 fathoms
	7 — N. by E. of Myggenæs point,	— 57 —
	12 — N.W. of Agraleide,	— 150 —
	Deep hole at north point of Nolsö,	— 100 —

Sæmundsson (1911 p. 92) briefly mentions that the branches in young colonies of *Hydrallmania falcata* are at times short, unbranched, and biserial, and that the same is often the case with the basal branches in somewhat larger colonies. Levinson also (1913 p. 308) mentions small pinnate colonies of 29 mm length from Hellebæk, Denmark, but without quoting further details as to the hydrothecæ. The frequent occurrence of the species in the Trondhjem Fjord has afforded an opportunity for closer study; the colonies are often very finely built.

Young colonies of *Hydrallmania falcata* may at times even at a length of 5 cm be singly pinnately branched, and it is then extremely difficult to distinguish them from *Sertularia*. The stem, which is here, of course, not yet spiral, has a hydrotheca at the base of each branch, a feature which is likewise common in larger colonies from the Trondhjem Fjord, and which I have found in most of the other colonies investigated from our seas. The hydrothecæ on the branches in young colonies, as also those on the branches in the pinnate basal parts of older ones, are arranged in two opposite rows (fig. LXXIII) in such a manner that the symmetrical plane of the hydrothecæ coincides with the vertically set broad plane of the branches; the hydrothecæ on these branches are alternately set, and with quite a considerable interval between. The distal half, or more, of the adcauline wall is free; the length of the free portion is from once to twice the diameter of the opening. Quite young colonies are thus extremely liable to be confused with small *Sertularia* colonies, unless the hydrothecæ are very carefully examined. The adcauline sinus in *Hydrallmania* is normally deeper than the abcauline; the difference is, however, at times very slight, and if the closing membranes have fallen away, it is very difficult to identify the colonies.

When the colonies are somewhat larger, the spiral coiling of the stem begins to make its

appearance at the top. And at the same time, a marked change takes place in the branches, which now turn 90° on their axis, so that their original broad plane becomes horizontal; further, a displacement of the hydrotheca towards the upper side of the branch also sets in, and the typical unilateral arrangement usual in the species now becomes apparent. Soon the bases of the hydrothecæ form a single row, and only the oral part is turned or bent out alternately to either side of the median plane, as a last trace of the biserial structure. Gradually also, secondary ramification takes place, the primary branches throwing out secondary branchlets, directed alternately to either side in the primary broad plane of the branch. In the more finely built colonies, the main branch has three, or more rarely four hydrothecæ between two branchlets; in colonies of coarser build, on the other hand, the number is only exceptionally as low as three, and as a rule we find four or more hydrothecæ between the origins of two secondary branches.

The features here mentioned are of importance in several respects. In the first place, they show that *Hydrallmania* colonies agree entirely in their mode of development with the remaining *Sertulariidae* having spiral stem, as far as this has been studied and described; they prove also, that the *Hydrallmania* colony, which at the first glance appears so entirely distinct, can be easily traced back to the typical colony in *Sertularia tenera* or *Thujaria thuja*. In the second place, the features in question reveal a striking resemblance between finer colonies of *Hydrallmania falcata* and *Hydrallmania distans* Nutting from Puget Sound; the likeness is so great that we are tempted to note them down without further consideration as synonyms, or rather, to regard the specimens from Trondhjem Fjord as belonging to the latter species. It would, however, be highly remarkable that this Pacific species should occur here and not elsewhere in the Atlantic. And closer study now shows that the Trondhjem Fjord type is not isolated, but is related, through every possible transition type, to the close and robust form which is predominant in the open sea, and which has always been taken as the type for *Hydrallmania falcata*. It is interesting also to note that several colonies in the material, as for instance some from Berufjord, have in among the lower normal branches one or two others of the *Sertularia* type. Elsewhere in the material we also find small colonies from several places agreeing with the young form from the Trondhjem Fjord, only of coarser build.

Nutting (1904 p. 126) notes as a distinctive character between *Hydrallmania distans* and *Hydrallmania falcata* that the latter species lacks hydrotheca on the stem at the base of the branch. This is, however, exceptional. The hydrotheca on the stem at the base of the branch may at times, especially in older colonies, be lacking, but in most cases it is to be found, and is always present in the somewhat smaller colonies. Nor can the difference mentioned by Nutting as existent in the gonothecæ be accepted as a specific character; it lies well inside the limits of variation observed in a single fairly luxuriant colony of *Hydrallmania falcata*. That I nevertheless refrain from definitely withdrawing *Hydrallmania distans* is due to the fact that my collections include no material of the species in question, and I am thus unable to determine whether possibly some characters not mentioned in Nutting's diagnosis might be found, sufficient to warrant specific distinction. The other American Pacific species also, *Hydrallmania franciscana* (Trask), calls for thorough investigation, its *raison d'être* being likewise highly problematical. The available drawings and data for the two species are not enough to decide the question.

Hydrallmania falcata has its chief occurrence in the littoral region of the boreal seas, and may exceptionally penetrate deeper down into the abyssal, where it has, however, once or twice been observed at 2000 metres depth. The species can move right up into arctic waters, and has even been met with in the Kara Sea; otherwise, its occurrence coincides with the presence of warmer currents in the high arctic areas. It may also penetrate some distance to the southward, as is shown by its more sporadic occurrence in the Bay of Biscay. In the North Atlantic also, it has been found off the east coast of America. It is thus the more surprising that it should never have been recorded from Greenland (fig. LXXIV) as it is one of the most common of all species in Iceland waters; on the west and east coast especially, the finds were so numerous that it was impossible to note them all on the

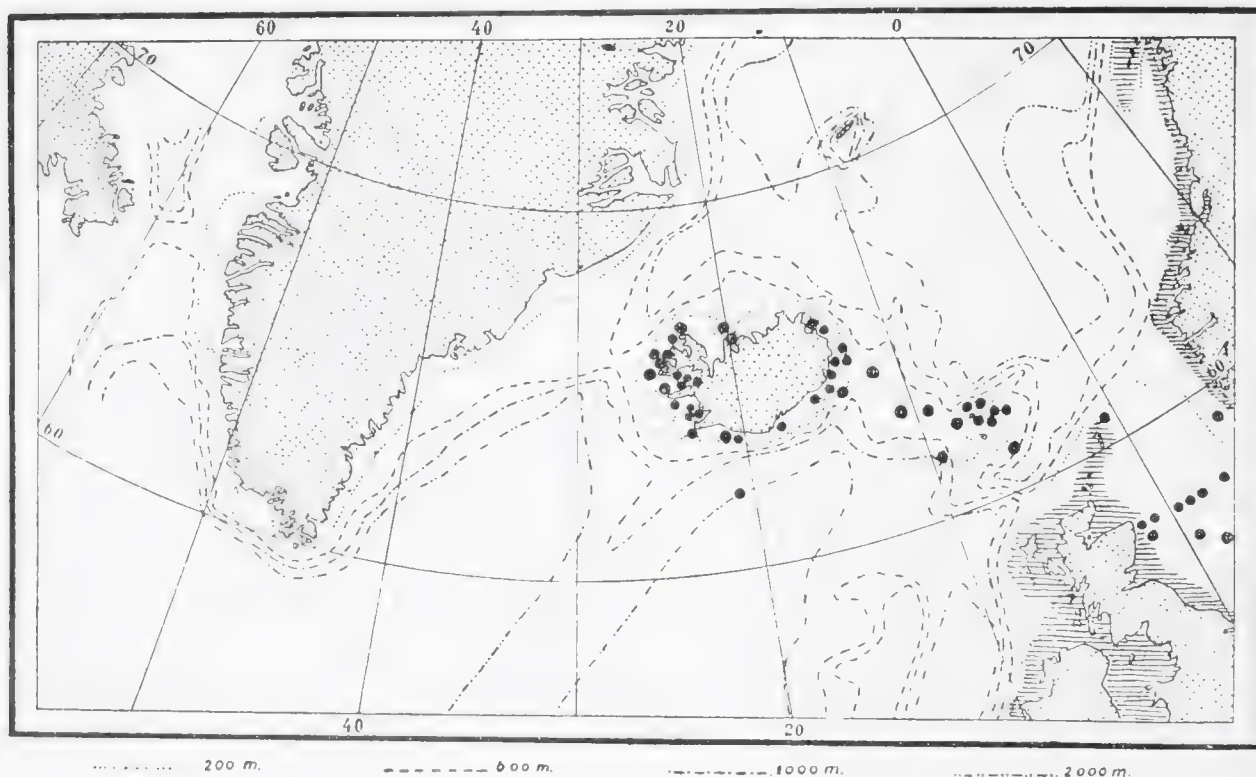


Fig. LXXIV. The distribution of *Hydrallmania falcata* in the Northern Atlantic.

In the hatched regions the literature notes a common occurrence.

chart. On the north coast of Iceland, *Hydrallmania falcata* is quite sporadic in its occurrence, and is not particularly numerous on the south coast. Between Iceland and the Faroe Islands, and on the northern side of the latter, it is again fairly numerous, while in the North Sea area and along the coast of Norway it appears as a character form.

Gen. *Thujaria* (Fleming).

Upright colonies with imbedded hydrothecæ. The hydrothecæ are of bilateral structure; the aperture is furnished with an abcaulinally fixed single opercular plate or membrane, attached to the margin of the hydrotheca, as a rule in a more or less pronounced sinus. The polyp has an abcauline strongly developed blind sack.

Thujaria thuja (Linné) Fleming.

1757 *Sertularia thuja*, Linné, Systema naturæ, Ed. 10, p. 809.

1828 *Thujaria thuja*, Fleming, A History of British Animals, p. 545.

Upright colonies, shaped like a bottle-brush, with dark-coloured, distinct monosiphonic hydrocaulus. The branches form an irregular, close double spiral round the indistinctly segmented stem, one branch to each joint. The stem has two rows of hydrothecæ; there are normally three hydrothecæ on the stem between two successive branches in the same row, the lowest in the branch corner. The branches form, at their point of origin, almost a right angle with the stem, and are repeatedly divided dichotomously, and curve slightly upward. They are segmented, with a large and varying number of hydrothecæ on each joint. The hydrothecæ form two opposite rows on the branches; their plane of symmetry coincides with the broad plane of the branch, which is horizontal. The hydrothecæ are entirely imbedded in the branches, with no free portion of the adcauline wall; they are subalternately arranged; at the top of the branch they have two lateral teeth, but in course of growth the adcauline sinus fills up, normally altogether. The interval between two successive hydrothecæ is about twice the opening diameter of the hydrotheca. The operculum is formed by a round plate abcaulinally attached.

The gonothecæ are situate on the upper side of the branch, and proceeding from close under the base of the hydrothecæ. They are oval, without ribs or wrinkles, with a short neck and broad round aperture.

Material:

"Ingolf" St.	2,	63°04' N.,	9°22' W.,	depth 262 fathoms,	5,3°
—	-	3,	63°35' N.,	10°24' W.,	— 272 — 0,5°
—	-	4	64°07' N.,	11°12' W.,	— 237 — 2,5°
—	-	15,	66°18' N.,	25°59' W.,	— 330 — ÷0,75°
—	-	34,	65°17' N.,	54°17' W.,	— 55 — —
—	-	51,	64°15' N.,	14°22' W.,	— 68 — 7,32°
—	-	87,	65°02,3' N.,	23°56,2' W.,	— 110 — —
—	-	95,	65°14' N.,	30°39' W.,	— 752 — 2,1°
—	-	96,	65°24' N.,	29°00' W.,	— 735 — 1,2°
—	-	98,	65°38' N.,	26°27' W.,	— 138 — 5,9°
—	-	127,	66°33' N.,	20°05' W.,	— 44 — 1,6°
"Thor"			66°19' N.,	23°27' W.,	— 115—120 metres
—			63°46' N.,	22°56' W.,	— 150 —

Greenland: Davis Strait, depth 66—67 fathoms (without further details)

Iceland: Seydisfjord, — 40 —

5 miles E. of Seydisfjord, depth 135 fathoms

Reykjavik (depth not stated)

6 miles W. of Iceland, 65°32' N., 24°38' W., depth 22 fathoms

Danmark Strait 65°39' N., 28°25' W., (depth not stated)

Iceland: Danmark Strait $66^{\circ}20' N.$, $25^{\circ}12' W.$, depth 96 fathoms

Adalvik, depth 5,5 fathoms (on roots of *Laminaria*).

The Faroe Islands: 6 miles N. by W. of Store Kalsö, depth 60 fathoms

Vestmanhavn (depth not stated)

Deep hole of north point of Nolsö, depth 100 fathoms

16 miles E. by S. of south point of Nolsö, depth 80 fathoms

Borönæs 13 miles N. 75 W., depth 30 fathoms.

Quite young colonies of *Thujaria thuja* are pinnate, and very difficult to distinguish from small colonies of *Thujaria laxa* Allman. The broad plane of the branches in such specimens, up to a couple

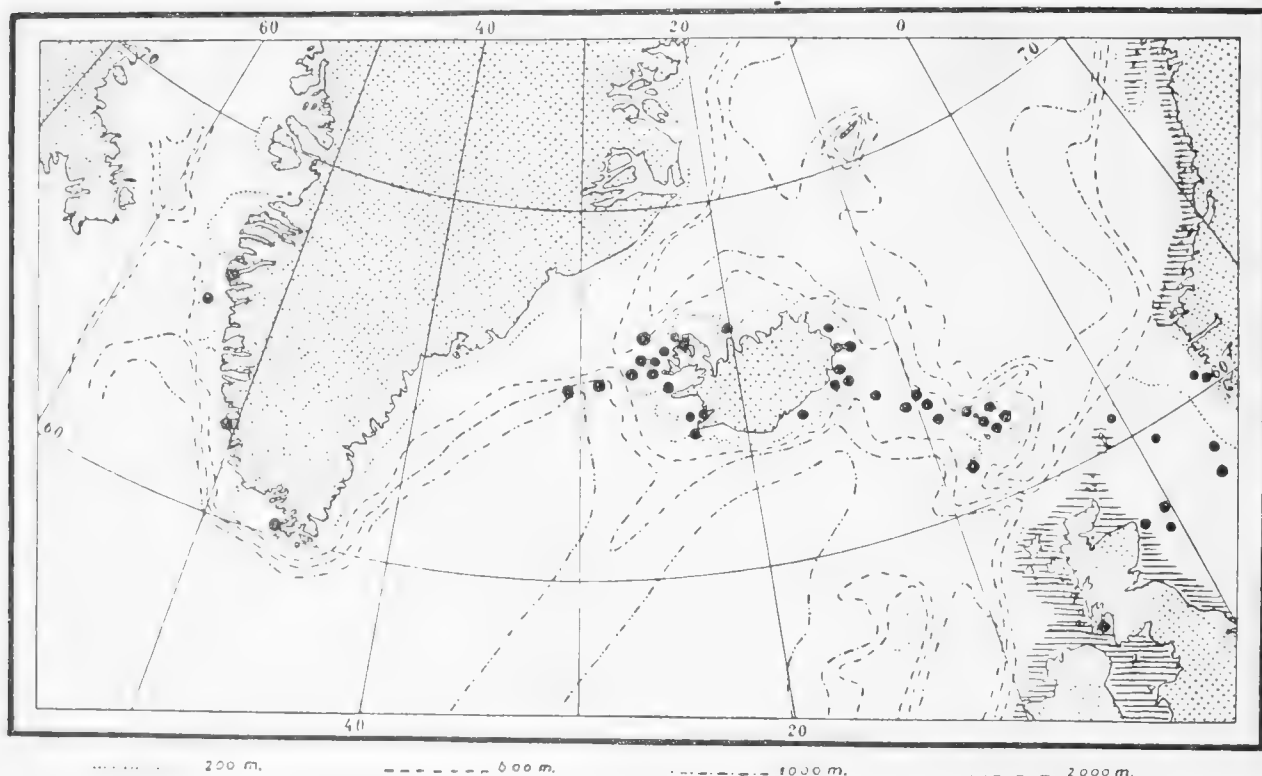


Fig. LXXV. The distribution of *Thujaria thuja* in the Northern Atlantic.

In the hatched regions a common occurrence is recorded.

of centimetres high, is vertical, and the branches are single. Here, however, the hydrotheca at the tip of the branch, which is of the *Sertularia* type, will as a rule reveal the identity of the species. The occurrence of this type of hydrotheca in *Thujaria thuja* is, as I have previously pointed out (1905) of considerable interest, as giving us a hint of the derivation of the *Thujaria* species from *Sertularia*.

Thujaria thuja is a boreal species, capable of moving far to the south; it is said to have been found both off the coast of Portugal and in the Mediterranean, but is not common south of Ireland. On the other hand, it does not enter the purely arctic waters; it has its chief distribution in the deep littoral region, but may occasionally be met with in the abyssal, and even deep down in the same, as is seen from the finds of the "Ingolf" at St. 95 and 96. In the North Atlantic (fig. LXXV) the

species is rare off the west coast of Greenland, and appears to be altogether lacking on the east coast. In Iceland waters, it is frequent on the west coast, and in Danmark Strait, and is also common on the east coast; common on the ridge between Iceland and the Faroe Islands, and around the latter Islands. In the North Sea, it is one of the most common species, and occurs also as a common form along the coast of Norway right up to the North Cape.

***Thujaria* sp. aff. *hippuris* Allman.**

From the "Ingolf" St. 24 (63°06' N., 56°00' W., depth 1199 fathoms, 2,4°) we have some colonies of a *Thujaria*, the identity of which cannot be determined with certainty. The colonies are slenderly pinnate, with branches openly set; the stem is very slightly pronounced, and in colonies 10 cm. high shows incipient spiral coiling at the top; the broad plane of the branches here assumes a horizontal position, while elsewhere it is always vertical. The branches form almost a right angle with the stem. The stem has two rows of hydrothecæ, and is divided into internodia bearing as a rule four branches, two to either side, alternately placed. There are three hydrothecæ between two successive branches on the same side of the stem, the lowest in the branch angle. The branches are irregularly segmented, with two to five, or rarely more, hydrothecæ on the internodium. The hydrothecæ are set in two rows on the branches; their plane of symmetry coincides with the broad plane of the branches; they are alternately placed on the slightly zigzag branches (and stems) and separated, in the same row, by intervals exceeding the length of the hydrotheca (fig. LXXVI). The hydrothecæ are deeply imbedded, and have a short free distal part of the adcauline wall; the length of this is at the outside half the opening diameter. The hydrotheca opening is round, with an even margin, and no indication of teeth or sinus; there is a large round opercular plate abcaulinally fixed. The colonies are unfortunately all sterile, with no indication of gonangia formation.



Fig. LXXVI.
Thujaria sp. aff.
hippuris. Part
of a branch
(× 40).

The colonies described appear in their general features to present some considerable likeness to *Thujaria hippuris* Allman, but are even more slender and with more widely set hydrothecæ than noted for the species in question (cf. Allman 1874, p. 473, pl. 45 fig. 2, and Kramp 1913, p. 26). The shape of the colony in *Thujaria hippuris* is very nearly the same as in *Thujaria thuja*. The largest colonies in the material show that the present species would also probably be of the same form when fully grown; the pinnate arrangement of the colonies, and the lack of secondary ramification in the branches, can therefore only be regarded as juvenile characters. The slight specific differences otherwise existing in the genus *Thujaria* call, however, for caution. The hydrothecæ in the colonies here concerned are not entirely imbedded, as is otherwise stated to be the case with *Thujaria hippuris*, but have a very short free distal part on the adcauline side; there is also a wider interval between the hydrothecæ in the same row, and the branches are bent slightly zigzag fashion. These points render it somewhat doubtful whether the specimens in question really belong to *Thujaria hippuris*, and the identity cannot be determined with certainty until the variational conditions of the species in question have been further elucidated. The enormous depth at which the colonies occur is very interesting, and will possibly serve to explain its extremely slender form.

***Thujaria laxa* Allman.**

- 1874 *Thujaria laxa*, Allman, Report on the Hydroida "Porcupine", p. 472, pl. 45, fig. 1.
 1895 *Thujaria lonchitis*, Marktanner-Turneretscher, Hydroiden von Ost Spitzbergen, p. 422.
 1903 *Thujaria Hjorti*, Broch, Die von dem Norwegischen Fischereidampfer "Michael Sars" gesammelten Hydroiden, p. 7, Taf. III, figs. 11—14.
 1904 *Thujaria immersa*, Nutting, Sertularidae, p. 66, pl. 9, figs. 3—4.

The upright colonies are as a rule pinnate in their lower parts, spirally curved in the upper, and with slender, secondarily dichotomously ramified branches, forming an open double spiral around the distinct main stem, which is somewhat darker in colour. In the pinnate portion, the broad plane of the branches is vertical, in the spiral it is horizontal. The stem has two opposite rows of hydrothecæ; there are as a rule 4 or 5 hydrothecæ between two successive branches on the same side (or in the same spiral), the lowest at the corner of the branch. The branches form almost a right angle with the stem, and are very nearly straight; they are irregularly segmented with a large number of hydrothecæ on each internodium. The hydrothecæ are set subalternately in two rows on the branches; their symmetrical plane coincides with the broad plane of the branch. The hydrothecæ are entirely imbedded, or have a very small free distal part of the adcauline wall, never more than half the opening diameter. The interval between two successive hydrothecæ in the same row is as a rule about equal to or slightly more than the opening diameter. The hydrotheca opening is round, the margin without any indication of teeth or sinus, and has a round opercular plate abcaulinally attached.

The gonothecæ are situated on the upper side of the branches close under the basis of the hydrothecæ. They are oblong, narrow pear-shaped, the male distally cut off transversely, the female more rounded, without neck.

Material:

"Ingolf" St.	3	63°35' N.,	10°24' W.,	depth 272 fathoms	0,5°
—	- 15	66°18' N.,	25°59' W.,	— 330 —	÷ 0,75°
—	- 32	66°35' N.,	56°38' W.,	— 318 —	3,9°
—	- 34	65°17' N.,	54°17' W.,	— 55 —	—
—	- 44	61°42' N.,	9°36' W.,	— 545 —	4,8°
—	- 51	64°15' N.,	14°22' W.,	— 68 —	7,32°
	- 87	65°02,3' N.,	23°56,2' W.,	— 110 —	—
—	- 94	64°56' N.,	36°19' W.,	— 204 —	4,1°
	- 98	65°38' N.,	26°27' W.,	— 138 —	5,9°
Greenland: Turner Sound,				— 120 —	
Cape Tobin,				— 57 —	(East Greenland Expedition)
Off Henry Land,				— 20 —	— — —
Off Henry Land,				— 160—200 —	— — —

Between the Faroe and the Shetland Islands, depth 255 fathoms.

Kara Sea, "Dijmphna" [labelled *Thujaria lonchitis* and *Thujaria articulata*].

Thujaria laxa belongs to the lower parts of the littoral region, and the upper part of the abyssal. It is an arctic species, which has been found from Davis Strait to Tajmyr; it is also represented

in the material from the cruise of the "Dijmphna" in the Kara Sea, but has there erroneously been referred either to *Thujaria lonchitis* or *Thujaria articulata*. From its arctic home, the species also spreads out into the boreal region (fig. LXXVII) where it has been recorded from the Faroe Islands and Iceland, and in Davis Strait. It will presumably also be found to occur off the coast of Norway, but in these waters, it has not hitherto been distinguished from *Thujaria lonchitis*, so that we have no reliable data up to the present.

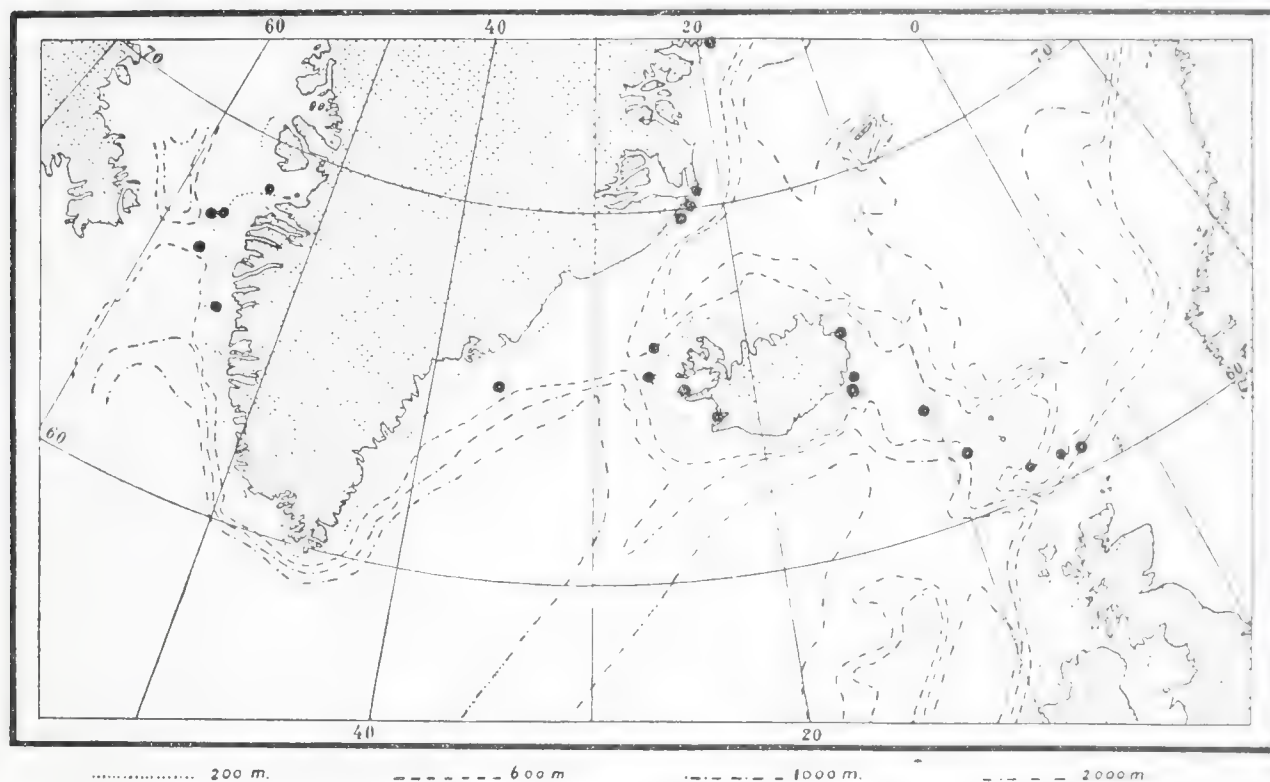


Fig. LXXVII. Finds of *Thujaria laxa* in the Northern Atlantic.

Thujaria alternitheca Levinsen.

1893 *Thujaria alternitheca*, Levinsen, Meduser, Ctenophorer og Hydroider, p. 52 pl. 7, figs. 15–20.

Robust, upright colonies with spiral, monosiphonic stem. The stem is divided by distinct segmentation into internodia of varying length, and has two single spiral tiers of hydrothecæ; there are from 3 to 6 hydrothecæ between two successive branches in the same spiral, the lowest in the branch corner. Normally, the sixth branch will be found straight above the first in the same tier. The broad plane of the branches is perpendicular to the axis of the stem (lies horizontally) and the branches form, at their point of origin, almost a right angle with the stem, afterwards curving somewhat downwards; they are secondarily branched dichotomously, and divided into internodia with five or more pairs of hydrothecæ. The hydrothecæ of the branches form two very close longitudinal rows; the hydrothecæ are closely set, each thrusting its opening part out upwards and sideways beyond the next, displaced alternately to either side of the median line through the base of the hydrothecæ, presenting a distinct approach to quadriserial arrangement. The hydrothecæ are entirely imbedded in the stem and branches, without any free distal part of the adcauline wall. The opening is circular, the margin without teeth or sinus, with a large round opercular plate abcaulinally attached.

The gonothecæ are set on the upper side of the branches. They are pear-shaped, with rudimentary neck and broad aperture.

Material:

"Ingolf" St. 31	66°35' N., 55°54' W.,	depth 88 fathoms	1,6°
— - 34	65°17' N., 54°17' W.,	— 55 —	—
Greenland: Davis Strait,	—	100 —	(without further details) [type specimen].
Iceland: Skagi,	—	20 —	[labelled <i>Thujaria lonchitis</i>]
Dyrafjord,	—	15 —	—

In all probability, this species also will prove to have a pinnate development stage, like the other, spiral *Thujaria* species. In the arrangement of the hydrothecæ, *Thujaria alternitheca* forms a parallel to *Abictinaria* (?) *fusca* (Johnston), and it is interesting here to note how the hydrothecæ, owing to their extremely close accumulation, thrust their opening part to one side or the other from the base of the next following. An investigation of the tip of the branch shows that this is a secondary phenomenon. The hydrothecæ are to begin with symmetrically situate, with their symmetrical plane parallel to the branch axis; only on the formation of a new distal hydrotheca is the aperture of the one behind it thrust out to the side. We have here, then, a typical instance of convergency, as towards *Abictinaria* (?) *fusca*, which cannot be taken as evidence of closer relationship, and thus does not afford any justification for uniting the two species mentioned, and other multiseriate forms in a special genus *Scelaginopsis*; any such would also have to include species with and those without blind sack, which can hardly be considered permissible.

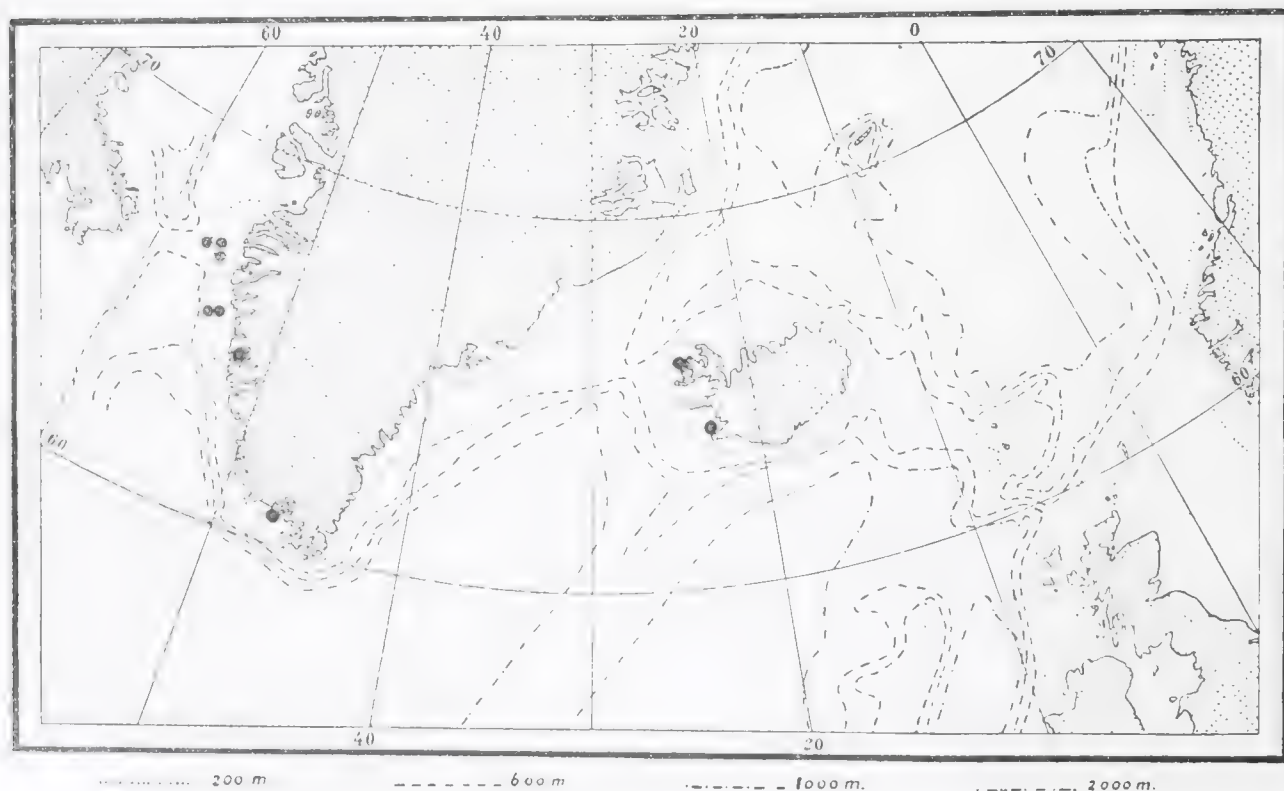


Fig. LXXVIII. Finds of *Thujaria alternitheca*.

Thujaria alternitheca is probably an arctic species of highly localised occurrence. It belongs to the deepest littoral waters. Previously, it was only known from Davis Strait, but is now found to occur also off the west coast of Iceland, where it has been confused with a form of much finer build, *Thujaria lonchitis*.

***Thujaria variabilis* nov. nom.**

1899 *Selaginopsis arctica*, Bonnevie, Den Norske Nordhavs-Expedition, p. 87, pl. 6, fig. 4.

Coarse, upright pinnate colonies with undivided branches. The stem is slightly zigzag, divided into internodia of irregular length, with from two to twelve regularly alternating branches and two single rows of hydrothecæ; the stem is not spirally coiled. The stem has from two to four, normally three, hydrothecæ between two successive branches on the same side, the lowest in the branch angle. The branches have four, exceptionally two or three, rows of hydrothecæ; on the four-rowed branches, the hydrothecæ are set in opposite pairs, the symmetrical plane of the one pair being then perpendicular to that of the next; three-rowed branches are spirally coiled, two-rowed straight, with the symmetrical plane of the hydrothecæ vertical. The hydrothecæ are broad and deeply imbedded, with a short, often quite insignificant free distal part of the adcauline wall, never more than a third of the opening diameter, or one-tenth to one-twelfth the length of the hydrotheca. The opening is round, with smooth margin, without teeth or sinus, and has a large opercular plate abcaulinally fixed.

The gonothecæ are set on the upper side of the branches, and proceed from close below the base of the hydrothecæ. The gonothecæ are inversely conical, distally cut off transversely, without neck.

Material:

Iceland, Reydarfjord, depth 80 fathoms (some of them labelled *Thujaria lonchitis*).

A number of very fine colonies belonging to this species have been incorrectly determined by Sæmundsson as *Thujaria lonchitis*, from which *Thujaria variabilis* is immediately distinguishable by its extremely robust appearance and thick branches. The colonies are interesting in several respects. They show, in the first place, that aberrant branches with fewer than four hydrothecæ rows are by no means rare, and in the second, that the number of hydrothecæ rows on a branch may vary from one internodium to another. There are thus some branches which are basally quadriserial, distally bi- or triserial; others again are biserial, triserial or quadriserial throughout their entire length, or only quadriserial at the extremities. This feature, then, is subject to great variation. It is also remarkable that biserial branches are straight, whereas the triserial, and exceptionally also the quadriserial, are twisted, so that the hydrothecæ here lie in very steeply ascendant spiral tiers about the branches. The normal quadriserial branch on the other hand, presents a compressed *Staurotheca* type, where the single hydrotheca pair is revolved as against the preceding pair, and has its plane of symmetry perpendicular to that of the latter; this also gives very close spiral lines in the arrangement of the hydrothecæ, as pointed out by previous investigators. The species, with its variations, gives a drastic exposure of the value attaching to the distinctive characters for the genera *Staurotheca* and *Selaginopsis*.

It is evident from the foregoing that *Selaginopsis arctica* Bonnevie must be classed under the

genus *Thujaria*, as I have already (1909 p. 222) placed it. The same genus, however, has formerly been made to include *Sertularia arctica* Allman and *Sertularia arctica* Thompson, which is incorrect. The proper method of proceeding here will be to alter the name of the present species, as being of later date, and this I have accordingly done, naming it, from the variable character of the branches, *Thujaria variabilis*.

Thujaria variabilis has only occasionally been found in arctic waters near Beeren Island, at Spitzbergen and off the Murman Coast at 38 to 86 metres' depth. Reydarfjord thus represents the most southerly find, and is also, with its 80 fathoms, the deepest.

Thujaria lonchitis (Ellis and Solander) Fleming.

- 1786 *Sertularia lonchitis*, Ellis and Solander, The natural history of many curious and uncommon Zoophytes, p. 42.
- 1828 *Thujaria articulata*, Fleming, A History of british animals, p. 545.
- nec 1766 *Sertularia articulata*, Pallas, Elenchus Zoophytorum, p. 137.
- 1847 *Thujaria articulata*, Johnston, A History of the British Zoophytes, p. 84, pl. 18, figs. 3—4.
- nec 1851 — — Busk, A list of Sertularian Zoophytes and Polyzoa from Port Natal, Algoa Bay . . . , p. 119.
- 1868 — — pars, Hincks, A History of the British Hydroid Zoophytes, p. 277, pl. 60.
- 1874 — — G. O. Sars, Bidrag til Kundskaben om Norges Hydroider, p. 106.
- 1884 — *lonchitis*, Kirchenpauer, Nordische Gattungen und Arten von Sertulariden, p. 24, pl. 14, fig. 7.
- (nec 1884 — *articulata*, Kirchenpauer, l. c. p. 26, pl. 14, fig. 8.)
- nec 1888 — *pectinata*, Allman, "Challenger" vol. 23, p. 69, pl. 33, fig. 1.
- 1890 — *lonchitis*, Marktanner-Turneretscher, Die Hydroiden des k. k. naturhistorischen Hof-museums, p. 236.
- 1893 — — Levinsen, Meduser, Ctenophorer og Hydroider, p. 53.
- 1899 — *articulata* pars, Bonnevie, Den norske Nordhavs-Expedition, p. 84.
- 1904 — *lonchitis*, Nutting, Sertularidae, p. 66, pl. 9, figs. 5—8.
- 1909 — *kolaënsis*, Jäderholm, Northern and Arctic Invertebrates, p. 88, pl. 8, figs. 17—18.
- ?1909 — *lonchitis*, Jäderholm, l. c. p. 89, pl. 9, fig. 3.
- 1909 — — Broch, Die Hydroiden der arktischen Meere, p. 174.

The upright colonies are as a rule pinnate throughout their entire length, more rarely with a spirally coiled distal part of the monosiphonic stem. In the pinnate portion of the colonies, the broad plane of the branches is vertical, in the spiral horizontal; the branches form almost a right angle with the stem, which is dark in colour. The stem is segmented in its lower part, but in the upper, the segmentation becomes almost entirely effaced; the branches are subalternately to alternately set. The stem has two rows of hydrothecæ; between two successive branches on the same side of the stem there will be two to three, rarely more (up to five) hydrothecæ, the lowest in the angle of the branch. The branches are not generally ramified, but may more rarely exhibit secondary dichotomous ramifi-

cation; they are divided into irregular internodia with a large and varying number of hydrothecæ on each. The hydrothecæ are alternately or subalternately set in two opposite rows on the branches; their symmetrical plane coincides with the broad plane of the branch. The hydrothecæ are deeply imbedded; the adcauline wall has a free distal part between half and once the opening diameter or between one-eighth and one-fourth the length of the hydrotheca itself. The hydrotheca opening is round, the margin as a rule having a more or less distinct abcauline sinus, so that the hydrotheca aperture often appears furnished with two slightly prominent teeth. The distance between two hydrothecæ in the same row is very slight, less than half the opening diameter. The operculum is formed by a large opercular plate abcaulinally attached.

The gonothecæ are set on the upper side of the branches, and proceed from close under the base of the hydrothecæ. They are narrowly pear-shaped, with a short, often almost rudimentary cylindrical neck, and broad aperture.

Material:

"Ingolf" St. 44 61°42' N., 9°36' W., depth 545 fathoms, 4,8°

— - 144 62°49' N., 7°12' W., — 276 — 1,6°

Greenland: Davis Strait, — 80 — (without further details).

The synonymy of this species is extremely difficult to determine; we are to a great extent forced to rely on geographical data. Kirchenpauer (1884) was really the first to point out what particular characters distinguish the two species which have been taken together under the name of *Thujaria articulata*; to him belongs the credit of having given the definite characterisation of that South Sea form for which he has — doubtless correctly — reserved the name *Thujaria articulata* (Pallas). This is specifically quite different from the northern species which has been given the same name, but which should properly be known as *Thujaria lonchitis* (Ellis et Solander). That the two have hitherto been so generally confused is due partly to the fact that writers have relied upon the records in the extant literature, partly to the frequent inability on the part of investigators to procure material of more than the one species. Thus it happens also, that even Bedot, in his brilliant work: "Matériaux pour servir à l'histoire des Hydroïdes" has committed the error of noting the two species as synonyms, despite the fact that the drawings given by Hincks (1868), and Allman (1888) could hardly be regarded as illustrating the same species. Stechow (1913 p. 152) and Broch (1914 p. 34) have, after further study of both species, given a closer definition of *Thujaria articulata*, from which, and from the descriptions given of *Thujaria lonchitis*, it is evident that they differ even more than is usual between other species of the genus in question.

Thujaria lonchitis appears to be an arctic circumpolar species, which may penetrate into the boreal areas. But as it has constantly been confused with related forms, especially with *Thujaria laxa*, its geographical character cannot be defined with certainty. From the list of material for the remaining northern species, we see that it has also in the waters here investigated constantly been confused with other *Thujaria* species, and it will therefore be most correct to leave the final decision as to its biogeographical position in abeyance, pending the acquisition of new and more reliable data.

Thujaria carica Levinsen.

1893 *Thujaria carica* Levinsen, Meduser, Ctenophorer og Hydroider, appendix, pl. 7, figs. 26--29.

The upright colonies are pinnate in their basal parts, spirally coiled in the distal, with branches secondarily somewhat ramified dichotomously; the symmetrical plane of the branches is vertical in the pinnate parts, but horizontal in the spiral. The stem has two single, opposite longitudinal rows of hydrothecæ; there are two to five, generally three hydrothecæ between two successive branches on the same side of the stem, the lowest in the branch angle. The branches are divided into irregular internodia with four to eight hydrothecæ on each; the hydrothecæ are set subalternately in two opposite longitudinal rows, their plane of symmetry coinciding with the broad plane of the branch. The hydrothecæ have a large free distal part; the length of the free portion of the adcauline wall exceeds the diameter of the opening, and is between one-third and one-half the length of the hydrotheca itself; the opening margin is smooth, without sinus, with a round opercular plate abcaulinally fixed. The interval between two hydrothecæ in the same row varies somewhat, but is never less than the opening diameter.

The gonothecæ are set on the upper side of the branches in the spiral parts of the colonies. They are asymmetrical oval to pear-shaped, with a rudimentary neck and broad, round opening.

Material:

"Ingolf" St. 143 62°58' N., 7°09' W., depth 388 fathoms, ÷ 0,4°

"Thor" 66°19' N., 23°14' W., depth 115-120 metres [labelled *Thujaria lonchitis*].

Iceland: 32 miles S. of Selvogstangar, depth 170 metres.

Kara Sea "Dijmphna" [type-specimen].

Thujaria carica is an arctic species known from the waters between Spitzbergen and Beeren Island to the New Siberian islands; in the high arctic tracts it belongs to the upper third of the littoral region. South of the range mentioned, the species has hitherto only been found at the southwest point of Iceland, and north of the Faroe Islands, where it moves down into the abyssal region. Up to now, it has not been recorded from Greenland, and thus appears to be an easterly arctic species.

Thujaria sp. aff. *distans* Fraser.

Material:

"Ingolf" St. 85, 63°21' N., 25°21' W., depth 170 fathoms

The small *Thujaria* colonies from the "Ingolf" St. 85 very much resemble *Thujaria carica*, and may possibly prove to belong to that species; there are, however, certain points of difference which render the identity somewhat doubtful, and for the present, these colonies should doubtless be kept apart from *Thujaria carica*. It is not unlikely that they really represent a distinct species, but as the colonies are quite small, and without gonangia, it is very difficult to give a thorough characterisation.

The colonies are pinnate, with simple branches. The stem, which is monosiphonic, is divided into irregular internodia, and lacks both branches and hydrothecæ on its lower part. A couple of centimetres from the base, the hydrothecæ begin to appear; they are set as a rule alternately in two opposite longitudinal rows. The stem is slightly zigzag, and has on its upper part, besides the hydrothecæ mentioned, also alternating branches; the largest colony which is of quite regular build has

throughout three hydrothecæ between the origins of two branches on the same side of the stem; in the two smaller colonies, on the other hand, the number varies from two to five, but these colonies are at the same time irregular in the whole development of the branches in several places. The division of the branches into internodia is highly irregular; there may be from two to nineteen hydrothecæ on the branch internodia. The hydrothecæ are set in two opposite rows; their symmetrical plane coincides with the broad plane of the branches, which is everywhere vertically placed, i. e. parallel with the axis of the stem. The distance between two hydrothecæ on the same side of the branch is very great, as a rule about $1\frac{1}{2}$ times the length of the hydrotheca itself. The hydrotheca (fig. LXXIX) is not particularly deeply imbedded in stem or branches; the distal third of the adcauline wall is free; the free part of the adcauline wall is straight, or not infrequently curving slightly upward. The opening plane of the hydrotheca is parallel with the branch axis. The aperture is round, the margin exhibits indication of a pair of broad lateral teeth, further accentuated by the abcauline sinus in which the large single opercular plate is fastened. The structural character of the polyp it was impossible to investigate, owing to the state of preservation of the material.

These colonies appear in the main to agree with the Pacific species *Thujaria distans* established by Fraser (1914 p. 197, pl. 32, fig. 123). There are, however, lacunæ in Fraser's description, so the identity cannot be determined with certainty. Fraser's species has often secondary dichotomous ramification of the branches; this must be considered as due to difference in age. On the other hand, the hydrothecæ in *Thujaria distans* appear to have a larger free portion; Fraser states "about one-half free", and the figures appended, which are not very carefully drawn, even show hydrothecæ more than half free; they give, moreover, no clear impression as to the character of the hydrotheca aperture, which is likewise somewhat vaguely treated in the diagnosis: "margin without distinct teeth but rather bilabial". Only when a conscientious description of the Pacific species is available will it be possible to decide whether the colonies here found in the North Atlantic should be referred to the same.



Fig. LXXIX
Thujaria sp. aff. *distans*
from "Ingolf" St. 85.
Part of a branch.
($\times 40$).

Family series Proboscoida (Broch).

Family Campanulariidæ.

The hydrothecæ are radially symmetrical, bell-shaped, without closing apparatus, and provided with a basal chamber separated off from the distal main part of the hydrotheca by a diaphragm, or by a simple ring-shaped thickening of the wall. The polyps can withdraw entirely into the hydrothecæ. The hydranth has a club-shaped proboscis, attached by a narrow base to the body of the polyp above the tentacle crown; the gastral endoderm is homogeneous, the stomach part not divided into separate regions. The colonies are stolonial or sympodial.

The diagnosis of the family as here given excludes the two bilaterally built genera *Silicularia* and *Eucopeella*; these two genera should, partly on account of their being bilateral, partly also from their peculiar, almost leathery hydrothecæ, and the small size of the latter, which can only accomodate the basal part of the contracted polyp, be separated off as a distinct family *Siliculariidae*, as I have pointed out already in a former work (1909). Nutting, in his latest work on *Campanulariidae* (1915) still treats the two families as one, though he gives no reason for so doing¹.

The *Campanulariidae*, as here defined, make up a well marked family which can hardly be the subject of much dispute; the generic sub-division of the family, however, is a highly debatable question, and a study of the literature thereupon affords an interesting example of the extent to which, even at the present day, it is found "convenient" (i. e. less troublesome), or "advisable" to persevere in the adherence to earlier tradition, or acceptance of biological phenomena, in dealing with the great group of the Hydroids. This is in fact the obstacle which for years has barred our progress towards an understanding of the group in question, its development, and the various degrees of relationship between its subdivisions. — I have in a previous work (1909) explained at length why, in the northern waters, it is only permissible to recognise two genera of *Campanulariidae* from a phylogenetic point of view, to wit, *Campanularia* and *Laomedea*. The description of *Laomedea sargassi* (Broch 1913 p. 13) does not weaken this standpoint. Nutting, however, opines (1915 p. 24) that "while there may be considerable argument on theoretical grounds for such a course, it undoubtedly leads to unnecessary and practically insurmountable difficulties when large numbers of species are to be handled and described". The correctness of this view is not immediately obvious. In the first place, it is hard to see why the same characters should be easier to handle as generic than as specific distinctions; furthermore, it should be borne in mind that the pursuit of science is not an armchair occupation. In comparison with large genera of other groups — the pennatulid genus *Pterocides*, for instance, or the cirriped genus *Balanus* — or even with the hydroid genus *Plumularia*, the species with which we are here concerned are neither more numerous nor more difficult of distinction; yet it has not hitherto been found necessary to break up one genus into several merely because it comprised a large number of species, or because these were difficult to distinguish one from another; any such subdivision should be based upon grounds of far greater scientific importance. The "insurmountable" difficulties in connection with the *Campanulariidae* arise from the enormous number of badly described species which have been established — often, moreover, on the basis of inadequate investigations with regard to the study of variations. The result is a state of things which absolutely precludes a thorough biogeographical survey. And this is just where the recognition of phylogeny as fundamentum divisionis would help us to clear matters up; from a biogeographical point of view, co-operation between phylogeny and biology is of the highest interest, and by giving phylogeny the precedence, with biology in the second place, we should obtain a sound basis and definite lines on which to set about a rational reconstruction of the chaos at present existing, particularly with regard to the *Campanulariidae*.

We have, as a matter of fact, to face the simple question, whether biology or phylogeny is to be regarded as the fundamental principle for systematics. The medusa system, in its present state, cannot help us in dealing with the thecophore hydroids. The plasticity of the pelagic organism under the influence of physical factors in its environment is

¹ Nutting still writes "*Campanularidae*".

enormous, and makes itself felt among the medusæ to the same degree as among other planktonic organisms. But the variation of single species under different conditions has been even less studied in the case of the medusæ than in that of the polyp generation, and our ignorance as to these and similar phenomena has given rise to a medusa system in which phylogeny and biological convergency or divergency have been intermingled to a tangled confusion. A very fine proof of this is afforded by the fact that the *Campanulinidæ* have their medusæ distributed throughout almost all the families of Leptomedusæ, and yet we cannot, from this, proceed to split up the polyp family in question into a similar series of new families. The question as to a division into genera on the basis of gonophore types should be decided by a reference to the genus *Hydractinia*. Following this principle to its logical conclusion, with the *Campanulariidæ*, we should have to make generic distinction between the male and the female of *Laomedea flexuosa* Hincks, where, as we know, the female gonophores are heteromedusoid, the males styloid. But if this is out of the question, what gonophore type can we consider as being generically adequate? The heteromedusoids are in reality the only ones which differ in principle from all remaining types, which, since the discovery of the reduced cryptomedusoid in *Grammaria abietina* (M. Sars) form a finite series. — In *Campanularia integra* (Macgillivray) [*Campanularia compressa* Clark] we find, during one part of the breeding season free medusæ, at another, sessile eumedusoids; there is thus no clearer limit between free medusæ and sessile gonophores in *Campanulariidæ* than in several other families. The only type of gonophore which appears to be of any value must then be that of *Gonothyraea*. This is a highly interesting biological phenomenon; phylogenetically speaking, it is a typical cryptomedusoid, (cf. Kühn 1913 p. 187) differing but little from the gonophores in *Cladocoryne*. Its systematic value really lies in the fact that in certain forms, it is thrust out from the narrower gonotheca without breaking loose. From a biological point of view, this is a most interesting phenomenon, and we cannot but call to mind the gonophores in certain *Tubularia* species, where the larvæ are likewise developed in the sessile, medusa-like gonophore; it shows how nature here, in another way, has arrived at the same result as in several of the *Diphasia* species, in protecting the larvæ during their period of development. Such care of the young occurs, of course, elsewhere in the animal kingdom, but in all other cases, it is regarded as a biological phenomenon, which from a phylogenetic — and thus also from a systematic — point of view is of quite subordinate importance.

It may also be worth while to glance at one of the most interesting genera, *Orthopyxis* L. Agassiz, which Nutting (1915 p. 63) again seeks to revive by the side of *Clytia* and *Campanularia*, all on the basis of the gonophores. In his generic diagnosis, Nutting refers to the Medusæ of *Orthopyxis* as "without tentacles or manubrium", and under the heading of *Orthopyxis compressa* (l. c. p. 66) he states that Torrey (1902) gives for this species an illustration of "a medusa with 4 tentacles just escaping from the gonangium"; under *Orthopyxis everta*, again (l. c. p. 68) he informs us that "the female, at least, contain medusæ which eject their ova into an acrocyst without liberating the medusæ". Nutting has here given us a striking illustration of the value both of the genus itself and of the characters on which it is founded. The genus in question is really a connecting link, standing as it does with one foot, so to speak, in each of the other biological groups which we find represented in the family *Campanulariidæ*.

Here, as elsewhere, when drawing the limits of a genus, we must seek to emancipate ourselves from the interesting biological features of the gonophores, and have recourse to Levinsen's fundamental point of view; the study of the nutritive polyps and the colonies themselves.

We find then, that the family falls into two great groups, according to the diaphragm of the polyp, the arrangement being further accentuated by the two fundamentally different colony formations, the stolonial and the sympodial. Levinsen (1893) believed to have discovered that the diaphragma of the one group or genus — *Campanularia* — was a double formation, consisting of a central, thin membranous diaphragm, proceeding from a circular inner thickening of the wall, the boundary between the main cavity of the hydrotheca and the basal chamber. A thorough investigation of the point has convinced me (1909 p. 183) that Levinsen's conclusion must be due to his not having employed microtome sections; for microtome series reveal the fact that the "diaphragm" in the *Campanularia* group is produced by the high power of resistance against dissolvent influences which characterises the basal part of the supporting lamella, and that a true diaphragm, i. e. a chitinous, membranous bottom under the basal ectoderm, is altogether lacking.

Nutting (1915 p. 9) has arrived at a different result. He supports his view upon an unpublished manuscript of his pupil, J. H. Paarmann, and on original preparations by the same hand. It is on Paarmann's original drawings also, that Nutting's text figures 24—44 are based. These figures appear to have been sketched from optical sections, not from microtome series, and present altogether the impression of being not particularly reliable. Nor is this impression removed by the following passage quoted by Nutting from Paarmann's manuscript: "The simple diaphragm can with difficulty be seen in optical section of the hydrotheca, while the complex diaphragm is plainly distinguishable without sectioning". Now the fact is, that the thickening of the wall in *Campanularia* is as a rule fairly easily visible, while the true diaphragm here, in such North-European species as I have been able to investigate, does not even show up in microtome section. — Paarmann has figured the "complex" diaphragm also in our European species *Campanularia verticillata* (Linné). He gives, as a matter of fact, two figures of this, and the two are not very much alike (Nutting 1915, figs. 38 and 43); I have not, however, succeeded in finding the membranous part of the diaphragm in European specimens of the species. Paarmann's drawing also reveals a peculiarity in *Laomedea flexuosa* Hincks (l. c. text figs. 9 and 26), the free margin of the diaphragm being here double, a phenomenon which is not discernible in Kühn's illustration (reproduced in Nutting's text fig. 47) and is similarly lacking in my preparations. Details of this sort are apt to cast some doubt upon the value of Paarmann's drawings. — We should note, however, that all the species in which Nutting, following Paarmann, finds a "simple" diaphragm, have sympodial colonies, while among species with "complex" diaphragm only two species are cited: *Obelia geniculata* (Linné) and *Obelia flabellata* Hincks, which have no stolonial colonies. From this it might be supposed that the two species should be regarded as types of a distinct genus, but this is not the case. Even in Paarmann's drawing (Nutting 1915, text fig. 41) the diaphragm of *Obelia flabellata* is simple; somewhat thicker, it is true, than in most *Laomedea* species, but by no means resembling the broad wall thickening in *Campanularia*. This, together with the sympodial growth of the colony, places the species undoubtedly in the *Laomedea* group. With regard to *Obelia geniculata*, it might be a somewhat different matter. This species

evinces a remarkably high power of variability in the thickness of its chitinous parts, a point which has been noted by Sæmundsson (1902 p. 57) and later by myself (1909 p. 190); this variation, moreover, also affects the diaphragm in a peculiar manner. In finely built specimens, the diaphragm is of the same structure as in typical *Laomedea* species, that is to say, it consists merely of a thin basal plate spread out below the base of the polyp; in colonies of coarser build, the chitinous thickening makes itself especially apparent in the adthecal part of the diaphragm, only approaching the margin at a much later stage, so that in longitudinal hydrotheca sections, the diaphragm appears triangular, supported on a broad base resting upon the hydrotheca wall. The diaphragm here, however, is in no wise more "complex" than before, and does not particularly resemble the low, ring-shaped wall thickening in *Campanularia*. Taking all this in connection with the sympodial development of the colonies, we can have no doubt we have here to deal with a typical *Laomedea*.

The figure of *Laomedea flexuosa* mentioned above as reproduced by Nutting after Kühn (1909 Taf. 17, fig. 7) shows the typical *Laomedea* diaphragm. A typical picture of what we find in *Campanularia* is shown in fig. 1, Pl. I.

Gen. *Campanularia* (Lamarck).

The colonies are stolonial, creeping or upright rhizocaulomes. The hydrothecæ have no true diaphragm, but are divided by an inner thickening of the wall, more or less restricted in extent, into a large outer cavity and a smaller basal. The polyp can withdraw entirely into the radially symmetrical hydrotheca; it has a club-shaped proboscis and homogeneous gastral endoderm.

Quite exceptionally we find, among certain species, a slight approach to the formation of upright colonies based upon a sympodial mode of ramification, so that one stalk may carry a single secondary lateral stalk with hydrotheca. This must be regarded as the earliest indication of the typical sympodial colonies which characterise *Laomedea*. The *Campanularia* species lack true diaphragm, but have a ring-shaped thickening of the wall (plate I fig. 1) which forms the upper limit of the basal cavity, and furnishes, in its superior part, the point of attachment for the basal supporting lamella of the polyp, which is fixed to the thickened part by a wreath of small chitinous bodies. The chitinous thickening may be broad and not very sharply defined, or more sharply defined and narrower, in which latter case it assumes the character of an incipient diaphragm, but also in this case it is restricted to a low ridge.

Campanularia volubilis (Linné) Schweigger.

1758 *Sertularia volubilis*, Linné, Systema naturæ, Ed. 10, p. 811.

1820 *Campanularia volubilis*, Schweigger, Handbuch der Naturgeschichte, p. 425.

Creeping colonies, from the stolons of which proceed the hydrothecæ stalks, these being as a rule distinctly coiled in a spiral throughout their entire length; more rarely, the spiral may be less marked in certain parts, or throughout the entire length of the stalk. The stalk invariably terminates in a distinct ball-shaped joint under the hydrotheca. The hydrothecæ themselves are not very

large, about twice as long as broad; they are very nearly cylindrical, or somewhat tumid in the lower third, and with a very slightly expanded opening section; the basal third or fourth part of the hydrotheca tapers down, after an evenly curved transition part, rapidly to the stalk. The basal cavity of the hydrotheca is small, separated off from the main chamber by a narrow, but as a rule fairly prominent ring-shaped thickening of the inner wall. The transverse section of the hydrotheca at the aperture is circular, the opening margin has from nine to thirteen low, but generally distinct, rounded teeth.

The gonothecæ proceed from the stolons. They are oval to bottle-shaped, with a very short, often ringed stalk, in the broad end, and a long and narrow, cylindrical distal neck. The gonotheca is smooth, often slightly asymmetrical, rarely with curved neck.

Material:

"Ingolf" St. 33 67°57' N., 55°30' W., depth 35 fathoms, 0,8°

— - 86 65°03,6' N., 23°47,6' W., — 76 — —

— - 87 65°02,3' N., 23°50,2' W., — 110 — —

"Thor", 65°52' N., 23°58' W., depth 62 metres.

— 64°16' N., 22°17' W., — 50 —

64°02' N., 22°33' W., — 34 —

Greenland: Kutdlisat, Disco (depth not stated)

Proven (— - —) [labelled *Clytia Johnstoni*]

Store Hellefiskebanke, off Holstensborg, depth 18—20 fathoms

Lille Hellefiskebanke (without further details)

Sukkertoppen, on *Boltenia* (depth not stated)

Frederikshaab (— - —)

Iceland: Seydisfjord, depth 6 fathoms

Vestmanö, — 25 —

Hvalfjord, — 22 —

Bredebugt, 65°17,5' N., 23°22' W., depth 7—12 fathoms

— 64°45,8' N., 23°55,2' W., depth 30 —

Stykkisholm, — 20—30 —

6 miles W. of Iceland, (without further details) | some of them labelled *Campanularia Johnstoni*

Patreksfjord, depth 15—50 fathoms

Off Dyrafjord, depth 30 fathoms.

The Faroe Islands: 6 miles N. by W. of Store Kalsö, depth 60 fathoms

7 miles N. by E. of Myggenæs point, depth 57 fathoms

Deep hole at north point of Nolsö, depth 100 fathoms.

Campanularia volubilis is a circumpolar boreal species, with a very wide distribution in the arctic areas; it would perhaps be more correct to describe it as an arctic-boreal species. It does not penetrate very far into the warmer waters, and the records as to its occurrence in the Mediterranean

would seem to be exclusively due to confusion with *Campanularia johnstoni* Alder (cf. Broch 1912 p. 51). The species belongs chiefly to the littoral region, especially its upper half, but may quite exceptionally penetrate some way down into the abyssal. Within the waters investigated, *Campanularia volubilis* is one of the most common *Campanulariidae*; it is but rarely found, however, out in the open sea regions, which must probably be understood as standing in connection with its bathymetrical character (fig. LXXX). The species is not uncommon in West Greenland waters, but on the east

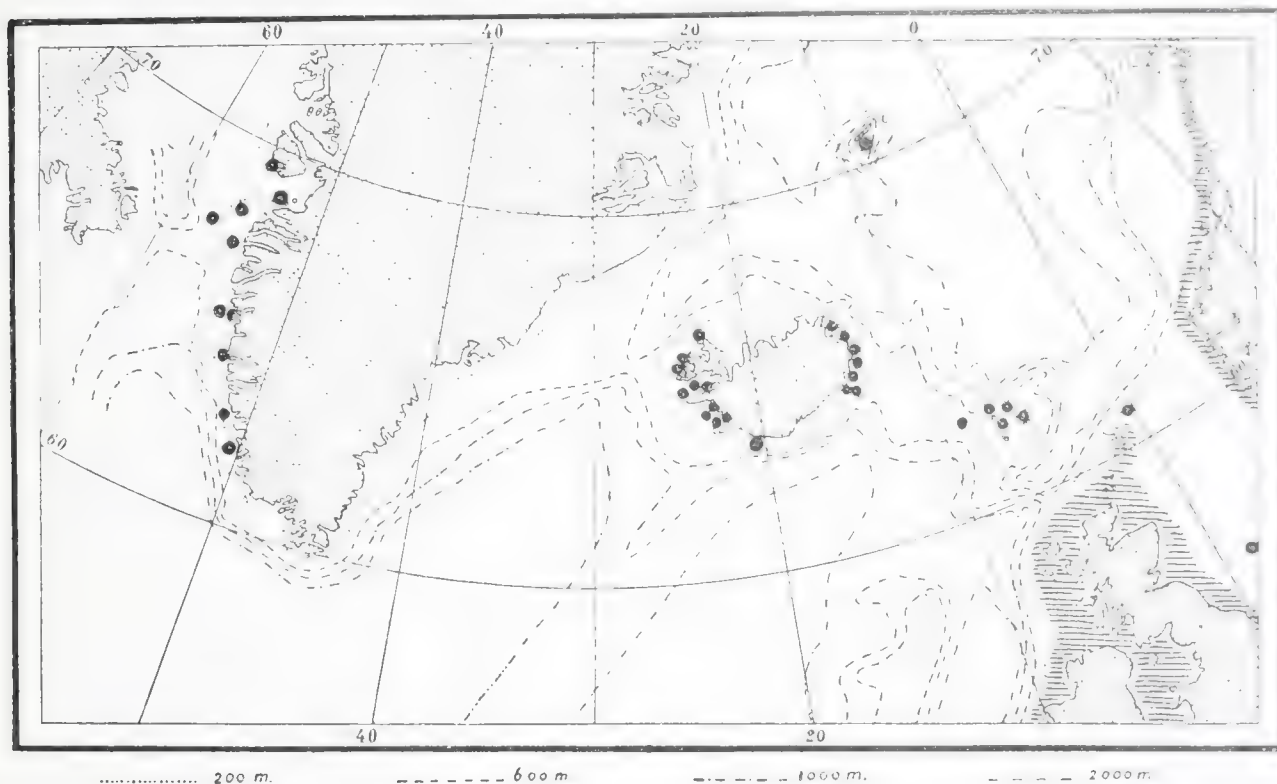


Fig. LXXX. The distribution of *Campanularia volubilis* in the Northern Atlantic.

In the hatched regions a common although scattered occurrence is stated.

coast of Greenland it has only been met with north of 76°. Of the Iceland coasts, it seems to prefer the east and west; it is less frequent at the Faroe Islands, and is stated as being of common, though scattered occurrence round the British Isles and off the west coast of Norway.

Campanularia verticillata (Linné) Lamarck.

1758 *Sertularia verticillata*, Linné, Systema naturæ, Ed. 10, p. 811.

1816 *Campanularia verticillata*, Lamarck, Histoire naturelle, vol. 2, p. 113.

nec. 1907 *Campanularia verticillata*, Hickson and Gravelly, National Antarctic Expedition, p. 23.

Upright, stiffly built rhizocaulomes, from the numerous tubes of which the hydrotheca stalks proceed, arranged approximately in wreaths. The stalks exhibit distinct rings, which are most pronounced near the origin, and nearer the hydrotheca; the stalk always terminates under the hydrotheca in a ball-shaped joint; the middle of the stalk is generally smooth. The hydrotheca is about twice as

long as broad, cylindrical, with a curved basal part tapering sharply towards the stalk. The hydrotheca is circular in transverse section near the aperture; the opening margin is furnished with ten to fourteen low, rounded teeth. The basal cavity of the hydrotheca is small; the limit between this and the large main chamber is formed by a low, but often fairly narrow and sharply defined ring-shaped inner thickening of the wall.

The gonothecæ proceed from the tubes of the rhizocaulome, and are attached to the same by an almost rudimentary stalk. They are bottle-shaped, with a broadly rounded basal part, and a short, rather narrow, tubulous neck, as a rule curved or somewhat asymmetrical.

Material:

"Ingolf" St. 127 66°33' N., 20°05' W., depth 44 fathoms, 5,6°.

"Thor" 64°02' N., 22°33' W., depth 34 metres

— 63°30' N., 20°14' W., — 80 —

Greenland: Davis Strait, depth 80 fathoms (without further details)

— — , 67°24' N., 55°39' W. (depth not stated).

Iceland: Vestmanö, depth 49 fathoms.

The Faroe Islands: 6 miles N. by W. of Store Kalsö, depth 60 fathoms

Glyversnæs near Thorshavn, together with red algæ (depth not stated).

Campanularia verticillata is a circumpolar arctic-boreal species, penetrating only slightly to the south, but still met with off the coast of France. The statements in one or two recent works, how-

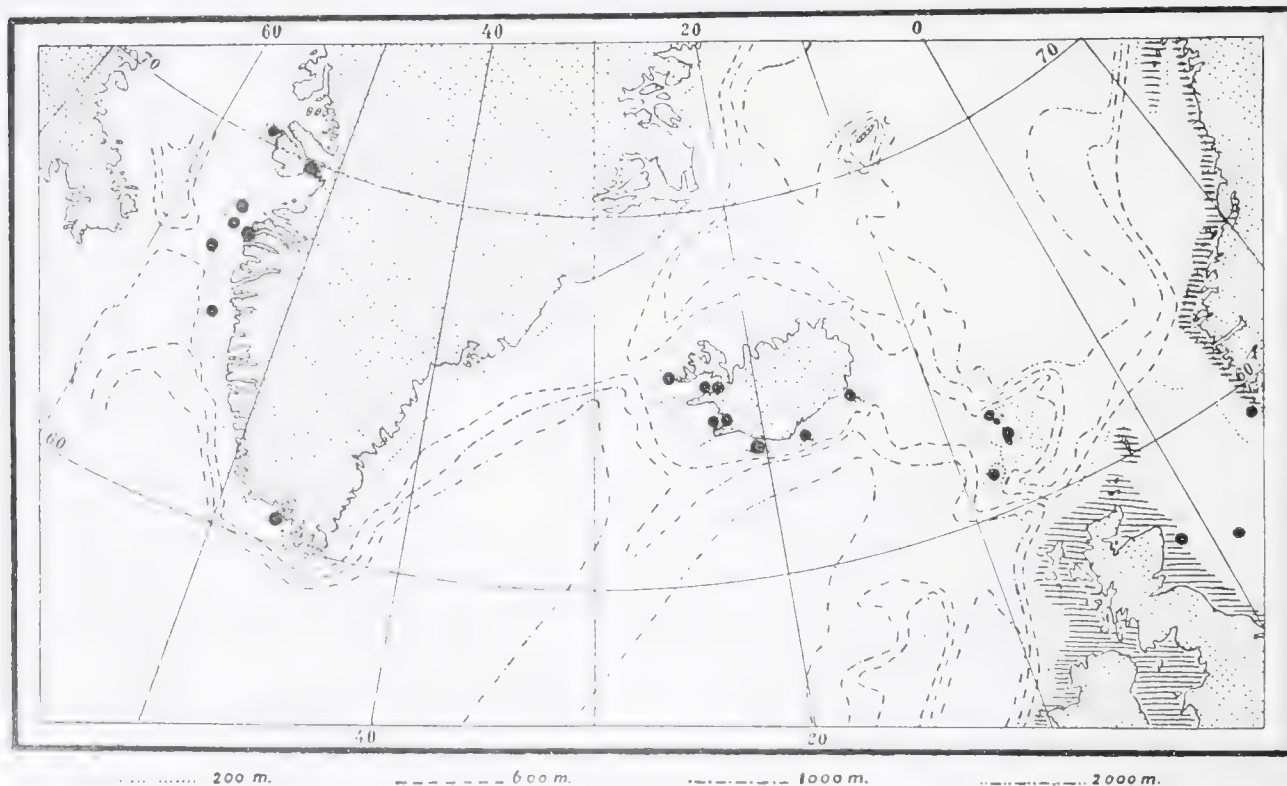


Fig. LXXXI. The distribution of *Campanularia verticillata* in the northern Atlantic.

In the hatched regions the literature notes a common occurrence.

ever, (Kramp 1914 p. 1069; Nutting 1915 p. 31) as to its also belonging to the antarctic region, are incorrect. Hickson and Gravely (1907 p. 23) mention, it is true, *Campanularia verticillata* var. *grandis* from Mc Murdo Bay, but what they found there was, as Vanhöffen has pointed out (1909 p. 294) really the altogether different antarctic species *Campanularia lobata* Vanhöffen, which has but one character in common with our northern *Campanularia verticillata*: the fact that the colonies are, as in the latter, rhizocaulomes. *Campanularia verticillata* is thus not a bipolar species. — *Campanularia verticillata* belongs to the middle parts of the littoral region, but may also be met with in quite shallow water; not infrequently also, it may penetrate down into the abyssal region, where it has even been found at no less than 600 metres' depth. Its distribution in our seas (fig. I,XXXI) shows that it is restricted to the coastal waters. The species is not uncommon on the west coast of Greenland; on the east coast, however, it has only once been taken north of 76°. In Iceland waters, it seems to keep chiefly to the southern coast; it is also found scattered about the Faroe Islands. Round the British Isles and off the coast of Norway it is of very common occurrence.

Campanularia groenlandica Levinsen.

1893 *Campanularia groenlandica*, Levinsen, Meduser, Ctenophorer og Hydroider p. 26 pl. 5 figs. 10—12.

Creeping colonies, from the stolons of which the hydrotheca stalks proceed; the latter may be ringed throughout their entire length, or, more commonly, having a smooth middle part; more rarely, the rings are found to be almost entirely lacking. The stalk invariably terminates under the hydrotheca in a ball-shaped joint. The large hydrothecæ are about $1\frac{1}{2}$ times as long as broad, typically bell-shaped, with gently curving sides, the greatest bend occurring in the basal third to fourth of the hydrotheca. At the aperture, the hydrotheca is polygonal in transverse section, with from ten to fifteen, generally twelve or thirteen straight or slightly concave sides, each running out at the opening into a markedly prominent rounded tooth. In the intervals between the teeth, the margin is slightly curved outwards. The basal chamber is quite low, and bounded at the top by a faintly developed narrow ring-shaped inner thickening of the hydrotheca wall.

The gonothecæ proceed from the stolons, and are attached to the same by a rudimentary stalk. They are elongated oval or bottle-shaped, with a fairly long, narrowly cylindrical neck; they are smooth or indistinctly wrinkled, generally somewhat asymmetrical; the neck is straight or more or less curved.

Material:

"Ingolf" St. 31	66°35' N., 55°54' W.,	depth 88 fathoms	1,6	
— - 34	65°17' N., 54°17' W.,	— 55	—	—
— - 87	65°02,3' N., 23°56,2' W.,	— 110	—	—
Greenland: Davis Strait		— 80	(without further details) Levinsen's	
Store Hellefiskebanke		(— — —)	type-specimens	
Iceland: 64°17,5' N., 14°44' W.,		— 75 metres	5,12 ^c	
Brædubugt, 65°45,8' N., 23°55,2' W.,		depth 30 fathoms.		

Campanularia groenlandica is a circumpolar arctic species belonging to the littoral region. It is undoubtedly of more common occurrence than the data to hand appear to show; this is probably owing to its having been confused with *Campanularia Hincksii* Alder, the prismatic hydrothecæ of which present a certain likeness to those of *Campanularia groenlandica*. That such confusion has taken place as far as the Norwegian waters are concerned would seem to be beyond doubt; we find here, that *Campanularia groenlandica* moves southward at any rate as far as Trondhjem Fjord (fig. LXXXII). The species has once or twice been encountered off the east and west coasts of Iceland; on the east coast of Greenland it has not been met with south of 76°, but along the whole of the west coast, which is its classical ground, it is fairly common, occurring often in company with *Campanularia volubilis*.

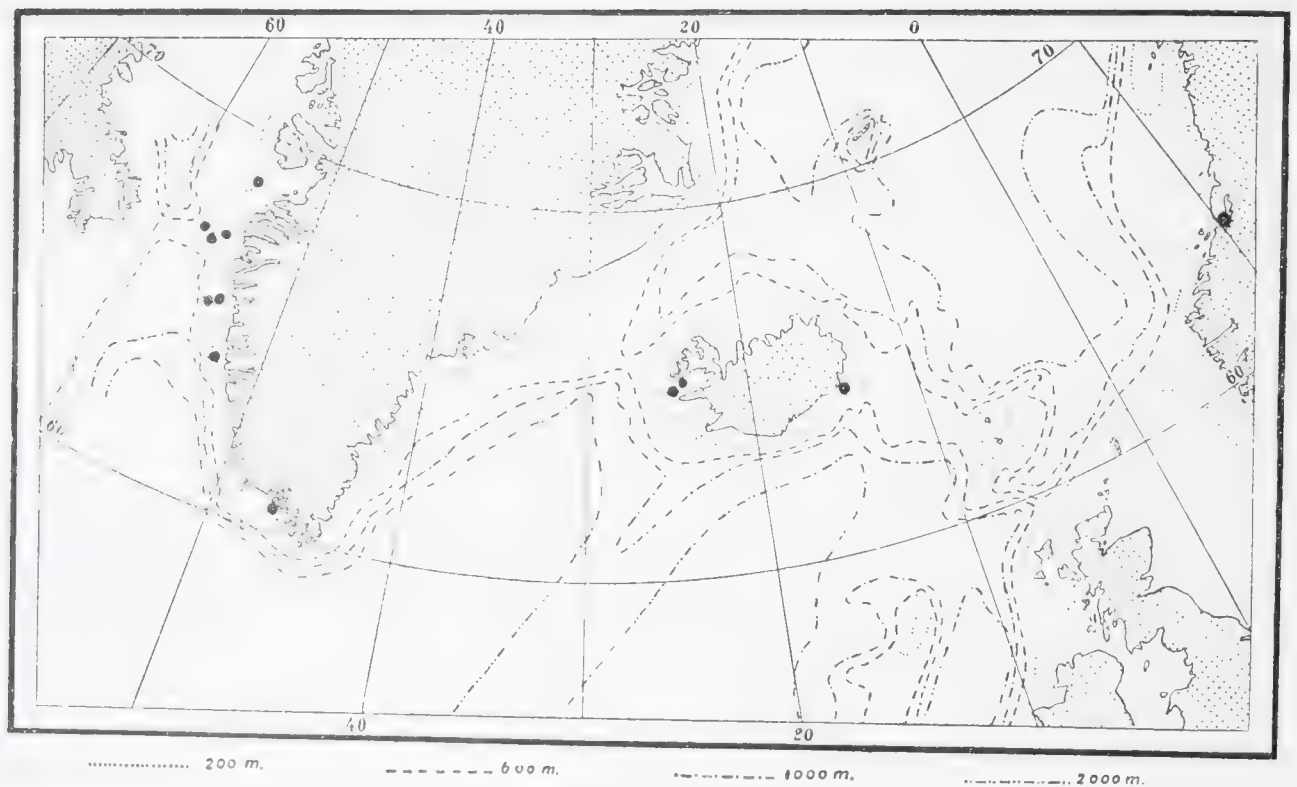


Fig. LXXXII. Finds of *Campanularia groenlandica* in the Northern Atlantic.

Campanularia speciosa Clark.

1876 *Campanularia speciosa*, Clark, Report on the Hydroids . . . Alaska, p. 214, pl. 9, fig. 11.

1913 *Campanularia magnifica*, Fraser, Hydroids from Vancouver Island and Nova Scotia, p. 164, pl. 11, figs. 1-3.

Creeping colonies, from the stolons of which proceed shorter or longer, irregularly wrinkled or ringed stalks, terminating under the hydrotheca itself in a ball-shaped joint. The large hydrothecæ are swollen at the bottom, with gently curving sides, narrowing upwards, but rapidly expanding again distally near the aperture, so that the opening margin curves strongly outwards. The margin is

furnished with seven to ten broad, slightly prominent teeth. The opening part curving more strongly out between the teeth, we have a broad furrow running from the highest point of the teeth and continuing some way down the hydrotheca, where it disappears. The longitudinal axis of the hydrothecæ is often somewhat curved. The basal cavity is very small, bounded at the top by a sharply defined, fairly prominent ring-shaped thickening of the inner wall.

The gonothecæ are attached to the stolons by a short, often rudimentary stalk. They are egg-shaped to oval, attached to the stalk by their broad end, and running out distally to a fairly long, narrow cylindrical neck. The gonothecæ are often slightly bent, and faintly and irregularly wrinkled transversely.

Material:

Greenland: Store Hellefiskebanke, depth 24 fathoms.

The above-noted synonym *Campanularia magnifica* Fraser (1917 p. 164, pl. 11, figs. 1—3) ought not really to require any further explanation. Fraser (1917 pl. 11, fig. 4) figures for purposes of comparison a gonotheca of *Campanularia speciosa* from Alaska; this is, like the one shown by Levinsen (1893 pl. 5, fig. 7) a developmental stage, only a little younger still. I have previously described the fully developed gonotheca after specimens from the Kara Sea (1912 p. 18 fig. 3); the conformity with Fraser's pl. 11 fig. 2 is evident. The other distinctive characters noted by Fraser are void of all significance, as will be seen from a somewhat richer material of the species.

Campanularia speciosa is a panarctic species, belonging to the shallower parts of the littoral region. Within the areas investigated, it is only known from West Greenland, where its most southerly occurrence was noted on the Store Hellefiskebanke.

Campanularia integra Mac Gillivray.

1842 *Campanularia integra*, Mac Gillivray, Catalogue of the marine Zoophytes of the neighbourhood of Aberdeen, p. 465.

- 1853 — *caliculata*, Hincks, Further notes on British Zoophytes, p. 178, pl. 5, fig. B.
- 1876 — *compressa*, Clark, Report on the Hydroids . . . Alaska, p. 214, pl. 8, figs. 5—6.
- 1901 — *Ritteri*, Nutting, Papers from the Harriman Alaska Expedition, p. 171, pl. 17, fig. 5.
- 1915 — — Nutting, Campanularidae, p. 35, pl. 2, fig. 2.
- 1915 — *integra*, Nutting, l. c. p. 33, pl. 1, fig. 7, pl. 2, fig. 3.
- 1915 *Orthopyxis caliculata*, Nutting, l. c. p. 64, pl. 15, fig. 4.
- 1915 — *compressa*, Nutting, l. c. p. 65, pl. 15, figs. 5—10.

Creeping colonies, from the stolons of which proceed hydrotheca stalks, smooth, or more or less distinctly ringed or spirally coiled, especially near their origin, and close under the hydrotheca; the stalk here always terminates in a ball-shaped joint. The hydrothecæ are large, inversely conical to nearly cylindrical; the conical ones taper gently down throughout their whole length towards the stalk; otherwise, the hydrothecæ are rounded smoothly off at their basal part; every possible kind of intermediate form may be found. The hydrotheca margin is smooth, with no indication of teeth,

often curving slightly outward. The basal chamber is well developed, and bounded at the top by a more or less pronounced ring-shaped thickening of the wall, often with a fairly thick base.

The gonothecæ are attached to the stolons by a short, generally rudimentary stalk. They are oblong oval to cylindrical; the wall is often furnished with oblique furrows forming a spiral, but may as often as not be quite smooth; all intermediate forms and types occur in one and the same colony. The gonophores are eumedusoid and sessile, or break loose during a part of the breeding season as defective medusæ (*Agastrea*).

Material:

"Ingolf" St. 34, 65°17' N., 54°17' W.; depth 55 fathoms

— - 127, 66°33' N., 20°05' W.; — 44 — 46°

"Thor" 64°02' N., 22°33' W.; — 34 metres

Greenland: Godhavn (depth not stated)

Jakobshavn (— - —)

Egedesminde (— - —)

Store Hellefiskebanke, off Holstensborg (depth not stated)

Davis Strait, depth 100 fathoms (without further details)

Sukkertoppen on algæ (depth not stated)

Godthaab (— - —)

Iceland: Bakkefjord, depth 10 fathoms

Vopnafjord, on littoral algæ

Seydisfjord, depth 6 fathoms

Vestmanö, on littoral algæ

Reykjavik, depth 2—3 fathoms

10 miles W. of Akranes, depth 26 fathoms

Keflavik, on littoral algæ

Breðbugt, 65°17,5' N., 23°32' W., depth 7—12 fathoms

— 65°18,5' N., 23°02' W., — 9—12 —

Stykkisholm — 30 —

The Faroe Islands: Svinö, on laminarians, depth 60 fathoms.

The synonymy of this species should be clear enough after the investigations which have been made by Levinsen (1893) Kramp (1911) and myself (1909); nevertheless we find, that Nutting (1915) again distributes the species among no fewer than four, and even places these in two different genera. With regard to the transition stages between *Campanularia integra* and *Orthopyxis caliculata*, we find the following (1915 p. 34) "Broch... says that the gonangia of the two species intergrade, but I have seen no instance of the kind, and, as the two may occur together, a very careful dissection would be necessary to place the matter beyond doubt". It is precisely such careful dissections which have convinced Levinsen and myself that all transition forms and variants do occur on the same stolons; we have only to regret that Nutting has not been equally conscientious in his methods of work.

It might be supposed that Nutting's material of *Campanularia integra* was restricted to some few colonies from scattered localities, each representing accidental variant groups, since the species is distributed under four separate names. The above indication of the methods pursued, however, taken together with the following statement, will give a good idea as to the cause (Nutting 1915 p. 34): "It should be understood moreover, that the present writer repudiates the idea that occasional intergradation in these low forms is sufficient ground for uniting species that are usually and perfectly distinguishable".

Giard (1899) has pointed out that the gonophores in *Campanularia integra* break away during

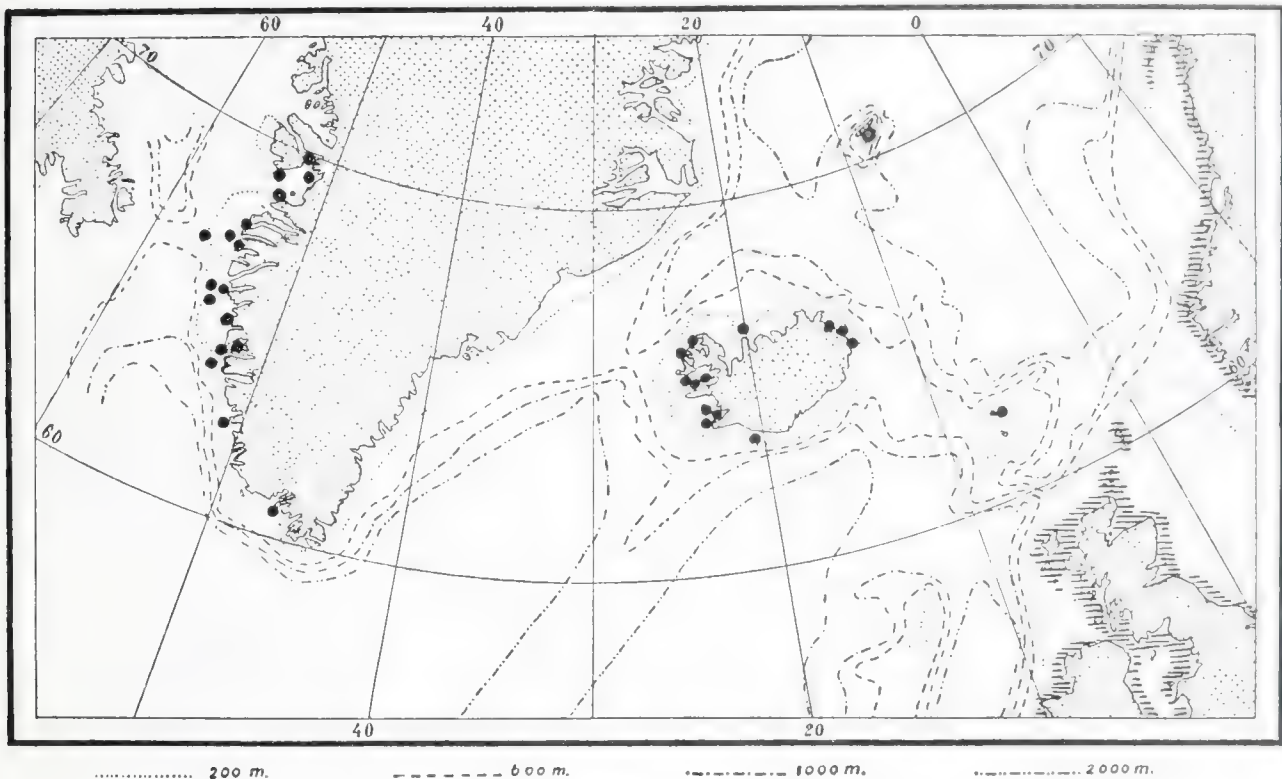


Fig. LXXXIII. Distribution of *Campanularia integra* in the Northern Atlantic.

In the hatched regions a common occurrence is stated.

part of the breeding season as defective medusæ, but are otherwise sessile. The correctness of this observation has been doubted, but is further confirmed through the investigations of Behner (1914). This writer refers to the species investigated as *Campanularia compressa* Clark, but it is impossible to discern wherein the difference between that species and *Campanularia integra* should be supposed to lie. The species thus stands with one foot in each of the two old genera *Campanularia* and *Clytia*. Nutting grasps at this as a welcome opportunity of separating off yet another genus, *Ortypyxis*, and believes to have rendered the system clearer and easier to deal with thereby.

Campanularia integra is a purely cosmopolitan species, which prefers the upper part of the littoral region, but may nevertheless occasionally be met with a good way down in the abyssal, exhibiting thus, apart from its enormous power of variation, a high degree of elasticity with regard to temperature. In respect of salinity, on the other hand, it appears to be more susceptible, and does

not move far up into the fjord waters. This may possibly also account for the distribution of the species within the area investigated (fig. LXXXIII). *Campanularia integra* is very common along the west coast of Greenland, but lacking on the east coast south of 76° N., according to what we know up to the present. The remarkable paucity of hydroids — arctic or boreal, — along this coast cannot be explained as due exclusively to temperature conditions, but must doubtless, judging from *Campanularia integra*, be partly occasioned by an accumulation of the fresh glacier water along the shore in contrast to the west coast, where warmer atlantic currents occasion a livelier interchange of water supply. A further peculiarity appears to lie in the scantiness of the species at the Faroe Islands; this, however, may possibly be accounted for by the fact that zoological bottom investigations have for the most part been made at greater depths than those at which the species chiefly lives in these waters.

Campanularia Hincksii Alder.

1856 *Campanularia Hincksii*, Alder, A notice of some new genera and species, p. 360 pl. 13, fig. 9.

Creeping colonies, from the stolons of which proceed long hydrotheca stalks, more or less distinctly ringed above their point of origin and under the hydrotheca; the stalk terminates below the hydrotheca in a ball-shaped joint. The hydrothecæ are very nearly cylindrical, with an evenly curving, rapid transition from the bottom to the stalk. In transverse section, the hydrotheca is polygonal, with eight to fourteen straight sides, each running out at the opening into a strong tooth, transversely cut off; the teeth may also at times exhibit a slight median incision. The basal cavity is small, bounded at the top by a sharply defined low and narrow ring-shaped thickening of the inner wall.

The gonothecæ are attached directly or by a rudimentary stalk to the stolons. They are elongated egg-shaped, broadest about the lower third, cut off transversely at the distal part, and with more or less prominent transverse furrows.

Material:

Iceland: Vestmanö, depth 28 fathoms.

North Sea: 57°07' N., 2°40' E., depth 37 fathoms.

Sæmundsson (1911 p. 77) mentions under this species an instance in which an approach to rhizocaulome formation was found, giving rise to a stem 1 cm high, whereby the colony assumed a considerable resemblance to *Campanularia verticillata*.

Campanularia Hincksii is a southern species doubtless more rare in northern waters than would appear from the records extant. It has frequently been confused with *Campanularia groenlandica*, which it somewhat resembles in a sterile state. Its occurrence in arctic waters is in reality very doubtful, and we must await further data before we can decide its biogeographical character with any certainty.

Campanularia Johnstoni Alder.

- 1856 *Campanularia johnstoni*, Alder, A notice of some new genera and species, p. 359, pl. 13, fig. 8.
 1860 *Clytia bicophora*, L. Agassiz, Contributions to the natural history of the United States, Second Monogr. vol. 4, p. 304, pl. 29, figs. 6-9.
 1868 — *johnstoni*, Hincks, A History of the British Hydroid Zoophytes, p. 143, pl. 24, fig. 1.

Creeping colonies, from the stolons of which proceed fairly long hydrotheca stalks, ringed at the base and below the hydrothecæ, the middle part generally smooth. The stalk terminates below the hydrotheca in a ball-shaped joint. The hydrothecæ are of varying size, from twice to $2\frac{1}{2}$ times as long as broad, cylindrical or inversely conical, with gently curving basal part. The hydrotheca is circular in section at the aperture; the opening margin is furnished with ten to sixteen sharp or pointedly rounded, highly prominent teeth. The basal cavity is rather large, terminating at the top in a narrow, sharply defined ring-shaped thickening of the inner wall, which in finely built specimens often presents the appearance of a very low diaphragm.

The gonothecæ are attached to the stolons by a short, ringed stalk. They are cylindrical, narrowing sharply at the base, cut off transversely at the distal end, and have deep transverse furrows generally forming a slowly ascending, close spiral. The gonophores develop into free medusæ (*Clytia*).

Material:

Iceland: Vestmanö, depth 25 fathoms.

The Faroe Islands: 6 miles N. by W. of Store Kalsö, depth 60 fathoms

deep hole at north point of Nolsö, — 100 —

61°40' N., 7°40' W., — 135 —

North Sea: 57°07' N., 2°40' E., — 37 —

Nutting (1915 p. 54) endeavours once more to divide *Campanularia Johnstoni* from *Clytia bicophora*, partly on the ground that the latter species is said to possess a diaphragm, partly because it is finer in the chitinous parts. The thinner chitinous formations involve, in *Campanularia Johnstoni* as in other species, a more restricted thickening of the wall, so that there may often be some considerable resemblance to a low diaphragm, and hydrothecæ of this type always exhibit a marked tendency to wrinkle up on preservation. There is, however, no reason to take all this as furnishing sound specific characters, and we also find that all other investigators agree in uniting the two species as *Campanularia Johnstoni*. This is doubtless correct.

Campanularia Johnstoni is a widely distributed southern form, which thrives to a marked degree upon *Sargassum*; it can, however, penetrate quite far down within the littoral region. In the northern seas (fig. LXXXIV) it appears as a southern visitor, found once so far to the north as Hammerfest on the coast of Norway, but otherwise only once met with at Bergen. In the North Sea it is more common, as also at the Faroe Islands; it is of very frequent occurrence round the British Isles, but rare in Iceland waters. Its distribution is that of a species typically belonging to the warm atlantic current.

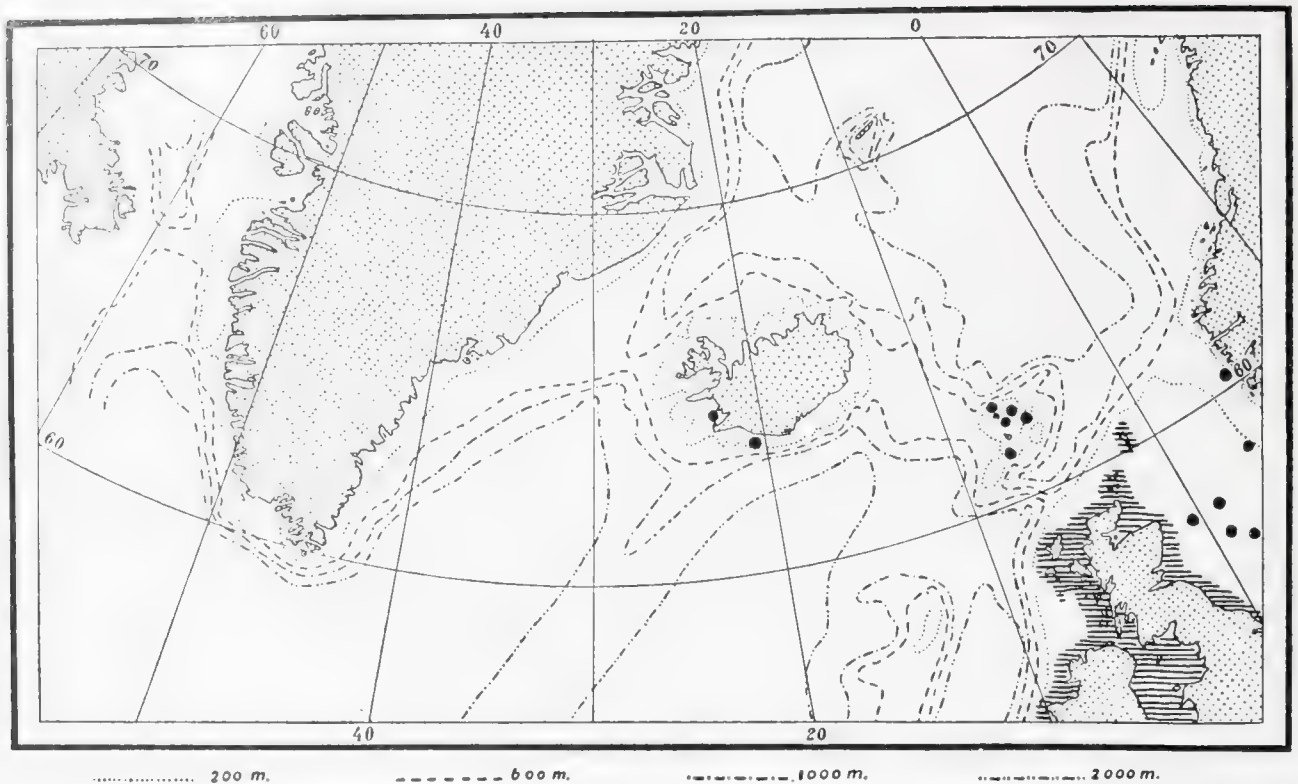


Fig. LXXXIV. The occurrence of *Campanularia Johnstoni* in the northern Atlantic.
In the hatched region a common occurrence is stated.

Gen. *Laomedea* Lamouroux.

Upright, sympodial colonies only occasionally exhibiting creeping parts with unbranched polyp stalks. The hydrothecæ have a typical broad diaphragm which forms the boundary between the main cavity and the basal chamber. The polyps can be withdrawn entirely into the radially symmetrical hydrothecæ. The hydranth has a club-shaped proboscis, and homogeneous gastral endoderm.

Lamouroux (1812) gave the following diagnosis of the genus: "Polypier phytoïde, rameux; cellules stipitées ou substipitées, éparses sur les tiges et les rameaux". This thus embraces the upright colonies of *Campanulariidae*, but Lamouroux has nevertheless placed *Campanularia verticillata* in his genus *Clytia*. There is thus no reason to suppress the name *Laomedea* for later and more narrowly restricted genera, and we cannot, on phylogenetic grounds, break up the genus as here defined on account of the biological peculiarities apparent in the gonophores. Nor is a better survey obtained by dividing the genus according to the nature of the gonangia, which it is in most cases impossible to determine with certainty from the colonies obtained. And that characters should be easier to handle when raised to generic rank than when applied to species it is not easy to understand.

In this genus, we find quite exceptionally that certain species, such as *Laomedea dichotoma* (Linné) may occur with creeping growth modification (cf. Broch 1913 p. 55); in such case, however, the diaphragm distinctly shows to what genus the species must belong. These creeping parts are

biological adaptations, which cannot in themselves afford grounds for distinction of species. How they arise, however, has not yet been thoroughly explained.

Laomedea flexuosa Alder.

1850 *Laomedea flexuosa* Alder, Description of three new British Zoophytes p. 440.

Upright, bushy colonies with monosiphonic hydrocaulus. There is no thickening of the periderm under the apophyses. Branches and stem are zigzag, with a short, ringed hydrotheca stalk from the apophyse at each bend. The hydrotheca is as a rule $1\frac{1}{2}$ times as long as broad, or hardly as much. In shape it is inversely conical, with sides very slightly curved and quite smooth margin. The basal cavity is large, bounded at the top by a distinct diaphragm. The hydrotheca exhibit no unilateral thickening of the wall.

The gonothecæ are carried on short ringed stalks proceeding from the apophyse beside the hydrotheca stalk. They are slenderly conical, as a rule tapering narrowly upward again at the distal part, and cut off broadly transversely at the distal end, without neck. The gonophores are dimorphous, the males styloid, the female heteromedusoid.

Material:

Iceland: Vestmanö, on the beach

Grindavik (depth not stated)

Reykjavik (— - —)

Grafarvogur (— - —)

Laomedea flexuosa is a boreal species characteristic of the tidal zone. On a former occasion (1909 p. 228 footnote) I suggested that the recording of this species from deeper water, down to 60 metres depth near Iceland, must be due to confusion with other species. A revision of Sæmundsson's material has entirely confirmed the correctness of this; the specimens he mentions (1902 p. 56) from deeper water are *Laomedea geniculata* (Linné) and *Laomedea longissima* (Pallas). Sæmundsson later (1913 p. 78, footnote) quotes in support Levinsen's determinations from the cruises of the "Hauch" (1893); these, however, must be taken with some reserve, and they will probably only be found correct provided they refer to water layers of very low salinity. In fjords with an intermixture of fresh water and in inland seas, the limits for the tidal zone will require to be somewhat modified, if it is to correspond with the conditions for fauna and flora in the tidal zone of the open sea shore. The deepest-living *Laomedea flexuosa* are met with out here on the upper *Laminaria*, which at deepest low water are not infrequently found lying dry; up in the fjords also the upper *Laminaria* must be taken as the limit, though they are here only found considerably deeper. Here, however, *Laomedea flexuosa* rarely goes so far down. The species is, as mentioned, boreal, characterising the tidal zone along the coast of Scandinavia, round the British Isles and at Iceland; it will probably, on further investigation, also prove to be common at the Faroe Islands. In Greenland waters, however, the species seems to be altogether lacking. It does not penetrate into the strictly arctic tracts.

Laomedea geniculata (Linné) Lamouroux.

1758 *Sertularia geniculata*, Linné, *Systema naturæ*, Ed. 10, p. 812.

1816 *Laomedea geniculata*, Lamouroux, *Histoire des Polypiers coralligènes flexibles*, p. 208.

1864 *Obelia geniculata*, Allman, *On the construction and limitation of Genera*, p. 372.

Upright, more rarely branched colonies with zigzag stem, the colony as a rule strongly built, and with an (inner) thickening of the perisarc under the apophyse; the stem and branches without rings. The hydrothecæ are borne on short, ringed stalks proceeding from the apophyses. Hydrothecæ long, about as long as broad, inversely conical with slightly curved sides. The abcauline side has as a rule a thicker wall than the adcauline. The basal cavity is large, bounded at the top by a strong diaphragm, which, especially in colonies with strongly developed periderm, has a thickened adthecal part. The hydrotheca margin is even, without indication of teeth or convexities.

The gonothecæ are set on short ringed stalks proceeding from the apophyses at the side of the hydrotheca stalks. The gonothecæ are slender, inversely conical, with a clearly defined, sharply tapering distal part, and short, narrow central neck. The gonophores develop into free medusæ (*Obelia*).

Material:

"Thor" 64°16' N., 22°17' W., depth 50 metres.

— 64°02' N., 22°33' W., — 34 —

Iceland: Bakkefjord, depth 25—32 fathoms

Seydisfjord, — 6 —

Vestmannaö, — 25 — [labelled *Laomedea flexuosa*]

Reykjavik, — 3—4 —

Olafsvik (depth not stated) [labelled *Laomedea flexuosa*]

Stykkisholm, depth 6—9 fathoms

Breðabukt, 65°17.5' N., 23°22' W., depth 7—12 fathoms

— 65°18' N., 23°02' W., — 9—10 —

Dýrafjörður, on *Laminaria* (depth not stated)

Örnundarfjörður, depth 10 fathoms

Adelvík, — 5—5.5 —

Öfjörður, on *Lernæa* (depth not stated)

Grimso, depth 15 fathoms

Víðarvík, — 13.5 —

Þístillfjörður, Raudarnes 1.5 miles in S.51E., depth 18 fathoms.

Jan Mayen, on *Laminaria*, depth 15 fathoms (East Greenland Expedition).

The Faroe Islands: Thorshavn, depth 3—15 fathoms

Vestmannaö, — 10 —

Sølmund, on *Laminaria* (depth not stated)

Svinö, depth 20 fathoms.

Laomedea geniculata is a cosmopolite, belonging to the upper part of the littoral region; in northern seas it is chiefly restricted to the *Laminaria*, but may also occur on deeper-growing *Zostera* and on shallow red algæ in large quantities. Albeit properly cosmopolitan, the species is nevertheless very rare in strictly arctic waters, but may occur here right into the White Sea. It is most frequent in the boreal areas. Along the coasts of Norway, round the British Isles, the Faroe Islands and Iceland it is present in great numbers (fig. LXXXV). It is also mentioned from Greenland, but no definite locality has yet been recorded.

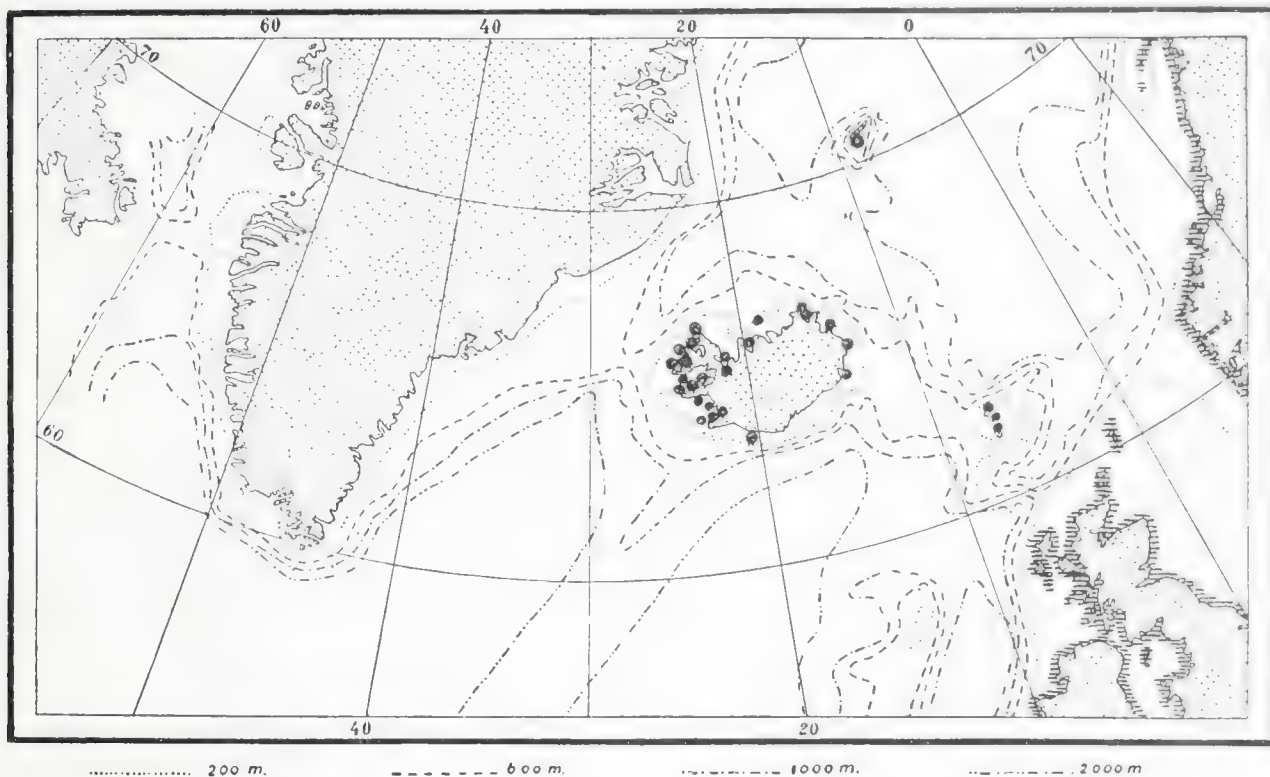


Fig. LXXXV. The distribution of *Laomedea geniculata* in the Northern Atlantic.
In the hatched regions the species is abundant.

Laomedea longissima (Pallas) Alder.

1766 *Sertularia longissima*, Pallas, *Elenchus zoophytorum*, p. 119.

1858 *Laomedea* —, Alder, *A Catalogue of the Zoophytes of Northumberland*, p. 121.

1868 *Obelia* —, Hincks, *A History of the British Hydroid Zoophytes*, p. 154, pl. 27.

1868 — *flabellata*, Hincks, l. c. p. 157, pl. 29.

Large graceful colonies with monosiphonic, brown stem, generally flexuous. From this proceed secondarily ramified branches, which again give off a hydrotheca stalk from the apophyse at each bend. There is no thickening of the periderm under the apophyses. The hydrothecae are about twice as long as broad, slender, inversely conical, with more strongly curved basal part. The hydrotheca margin is more or less curved, at times with distinct teeth, at others quite smooth. The basal chamber is fairly large, and bounded at the top by a finely built but distinct diaphragm.

The gonothecæ are borne on short, ringed stalks, proceeding from the apophyses beside the hydrotheca stalks. They are oblong, inversely conical, distally cut off transversely with a central short and narrow, almost tubulous neck. The gonophores develop into free medusæ (*Obelia*).

Material:

"Thor" 64°02' N., 22°33' W., depth 34 metres [labelled *Laomedea gelatinosa*]

— 63°30' N., 20°14' W., — 80 —

— 58°11' N., 2°28' W., — 60 —

Greenland: Jakobshavn (depth not stated)

Provens havn (— - —)

Holstensborg (— - —)

Tasiusak, depth 3–5 fathoms (East Greenland Expedition).

Iceland: Berufjord, depth 6 fathoms [labelled *Laomedea flexuosa*]

Hornafjord (depth not stated) [labelled *Laomedea Lovenii*]

Vestmanna, depth 25–28 fathoms [some of the specimens labelled *Laomedea flexuosa*]

10 miles W. of Akranes, depth 26 fathoms [labelled *Laomedea flexuosa*].

Stykkisholm, depth 20–30 fathoms [labelled *Laomedea flexuosa*]

Kollafjord, — 4–5 —

Dyrafjord (depth not stated).

The Faroe Islands: 5 miles N. by E. of Myggenæs point, depth 50 fathoms.

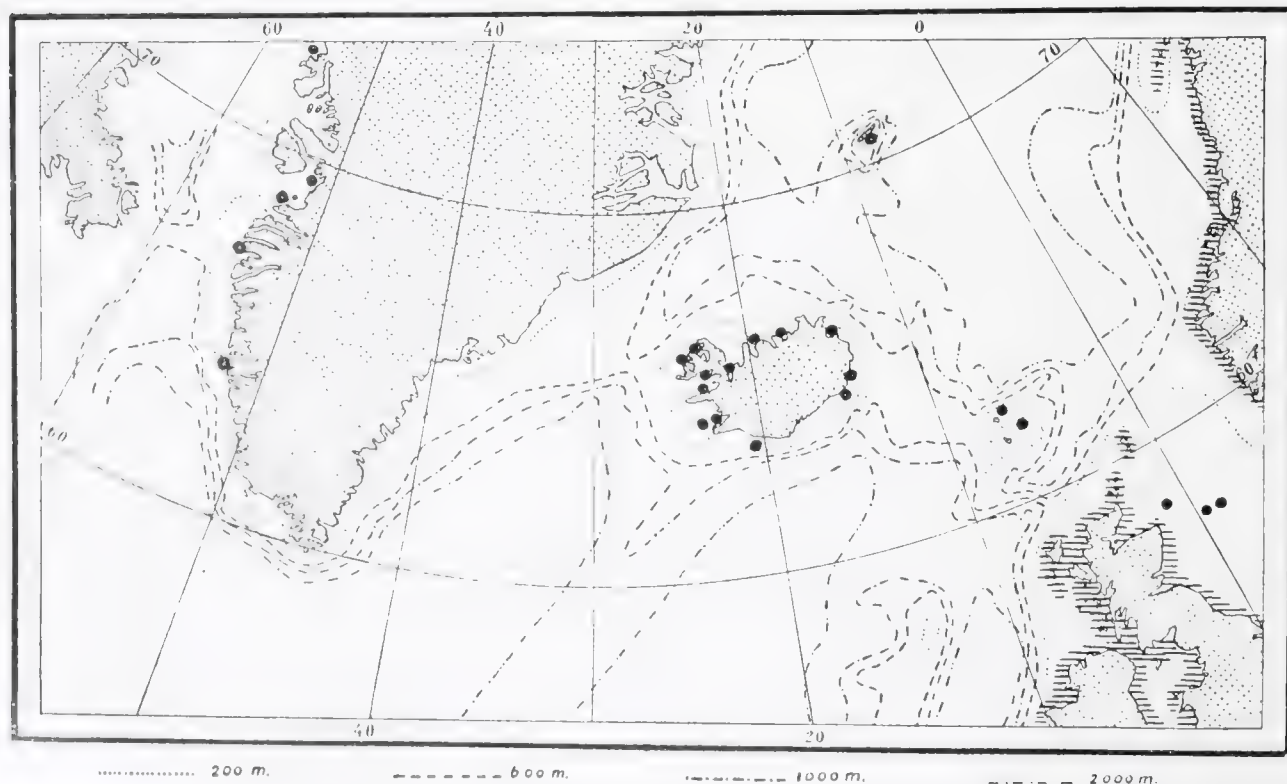


Fig. LXXXVI. The distribution of *Laomedea longissima* in the Northern Atlantic.
In the hatched regions a common occurrence is stated.

Sterile colonies of this species with almost or entirely smooth margin may at times present a certain resemblance to *Laomedea flexuosa*, and have frequently been confused with this species by Sæmundsson. — Nutting (1915 p. 73) endeavours to revive *Obelia flabellata* Hincks on the ground that the extreme branches of this species exhibit dichotomous ramification, whereas in the present species they are "flabellate"; unfortunately, however, he does not further explain the difference between the two terms. In the present colonies, both might often apparently be applied to the same branch. Nor does his other distinctive character, the fact that the branches in *Obelia longissima* are "regularly alternate" while those in *Obelia flabellata* are "alternate or opposite" give us any sound basis to work on. Bonnevie (1899 p. 71) is undoubtedly right in uniting the two species, and they cannot be revived on the strength of what Nutting here seeks to show.

Laomedea longissima appears to be a cosmopolitan species, albeit the data on record from tropic-subtropical waters are but scanty. The species belongs to the upper third of the littoral region, and goes far up into arctic waters, where it has a circumpolar distribution. In the area investigated (fig. LXXXVI) it appears to be entirely lacking in East Greenland waters, but is otherwise fairly regularly met with on all coasts.

***Laomedea hyalina* (Hincks) Levinsen.**

1866 *Gonothyræa hyalina*, Hincks, On new British Hydroida, p. 297.

1893 *Laomedea* — Levinsen, Meduser, Ctenophorer og Hydroider, p. 28.

Finely built upright colonies with monosiphonic main stem, the latter being, like the main branches, generally brown in colour. The colony often assumes a bushy appearance, owing to irregular ramification. The hydrothecæ are carried on short ringed stalks proceeding from the branch apophyses; the latter are set in a plane on the branch directed alternately to either side. The hydrothecæ are slender, inversely conical to cylindrical, tapering somewhat more at the basal part toward where the stalk begins; they are twice to three times as long as broad. The hydrotheca margin is furnished with low teeth, having a slight, often almost imperceptible median sinus in their distal end, which is cut off almost straight, so that they are divided into two denticles; from this sinus a slight furrow runs for a varying distance down the hydrotheca on its outer side. The basal chamber is small, bounded at the top by a thin, but well developed diaphragm.

The gonothecæ are borne on short, ringed stalks, proceeding from the apophyses beside the hydrotheca stalks. They are inversely conical, cut off straight at the distal end, without neck. The gonophores develop into crypto-medusoid meconidia, which extend out from the gonotheca without breaking away; the larval development takes place in the interior of the meconidium. (*Gonothyræa* medusæ).

Material:

"Ingolf" St. 34, 65°17' N., 54°17' W., depth 55 fathoms.

"Thor" 66°23' N., 14°24' W., — 45 metres

— 65°52' N., 23°58' W., — 62 — [labelled *Laomedea longissima*]

— 64°16' N., 22°17' W., — 50 —

- "Thor" 64°02' N., 22°33' W., depth 34 metres
 — 63°30' N., 20 14' W., — 80 — [labelled *Laomedea Loveni*]
 Greenland: Prøven (depth not stated)
 Umanak (— - —)
 Christianshaab (— - —) [labelled *Gonothyræa Loveni*]
 Egedesminde (— - —) [labelled *Gonothyræa Loveni* and *Obelia longissima*]
 Store Hellefiskebanke, depth 32 fathoms
 Sukkertoppen, on *Psolus* and *Boltenia* (depth not stated)
 — (depth not stated) [labelled *Obelia longissima*].
 Iceland: Hvalfjord, depth 22 fathoms.
 The Faroe Islands: without further details [labelled *Gonothyræa Loveni*]
 6 miles N. by W. of Store Kalsö, depth 60 fathoms
 Deep hole at north point of Nolsö, — 100 —

Laomedea hyalina is very closely allied to the *Laomedea Loveni* Allman, so much so that the two species have very often been confused. The characteristic distinctive marks of *Laomedea hyalina* are the fine narrow furrows running from the teeth some way down over the side of the hydrotheca, often giving the teeth themselves a double point. Nutting (1901 p. 352) mentioned intermediate forms between the two species from Plymouth; as however, the furrows in question are not noted by Nutting in the American waters, it is doubtful which of the species he has here been investigating. Probably all his specimens were typical *Laomedea Loveni*.

Laomedea hyalina must, from the data on record, be characterised as an arctic boreal, atlantic species. Its true home appears to lie at the transition between boreal and truly arctic regions, and from there it extends both north and south, everywhere within the upper third of the littoral region. Kramp (1914 p. 1071) notes the species as circumpolar, citing in evidence Clark (1876 p. 215) who mentions a *Gonothyræa hyalina* from Alaska. Marktanner-Turneretscher however, (1895 p. 408) has pointed out that Clark's specimens represent the type of a distinct species, *Laomedea Clarki* (Marktanner-Turneretscher). The validity of the species may seem somewhat doubtful, and it is highly probable that Kramp is correct in his geographical characterisation, but new and conscientious investigations in American waters will be needed before we can be fully certain. *Laomedea hyalina* is widely distributed within the waters investigated (fig. LXXXVII). It is surprising to find that a species having so wide a distribution in the arctic regions appears to be altogether lacking in East Greenland waters; it is otherwise of general occurrence within the area concerned, but becomes less frequent around the British Isles and off the southern west coast of Norway.

***Laomedea gracilis* M. Sars.**

- 1851 *Laomedea gracilis*, M. Sars, Beretning om en i Sommeren 1849 foretagen zoologisk Rejse, p. 138.
 1868 *Gonothyræa gracilis*, Hincks, A History of the British Hydroid Zoophytes, p. 183, pl. 36, fig. 1.

Upright colonies, slightly and irregularly branched, finely and stiffly built. There are no distinctly prominent apophyses, but the branches and hydrotheca stalks proceed from a faintly marked

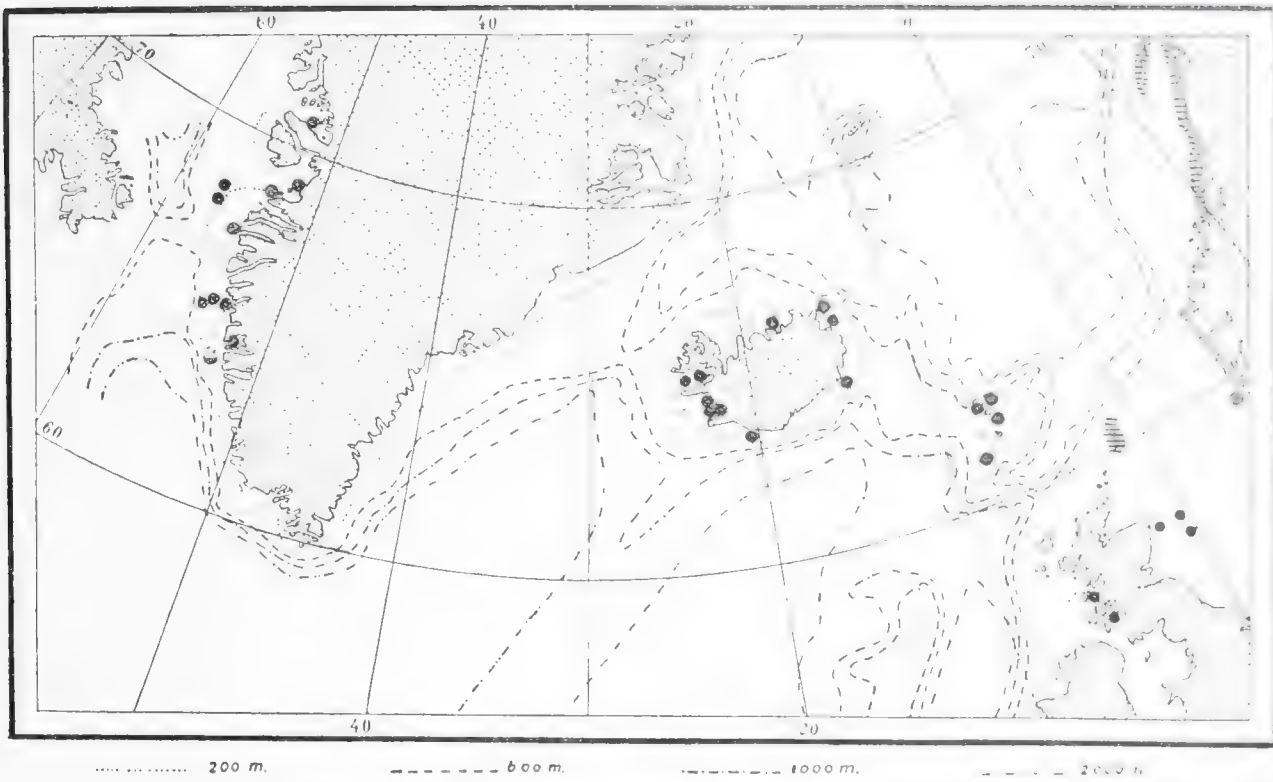


Fig. LXXXVII. The distribution of *Laomedea hyalina* in the Northern Atlantic.
In the hatched region the literature notes a scattered occurrence.

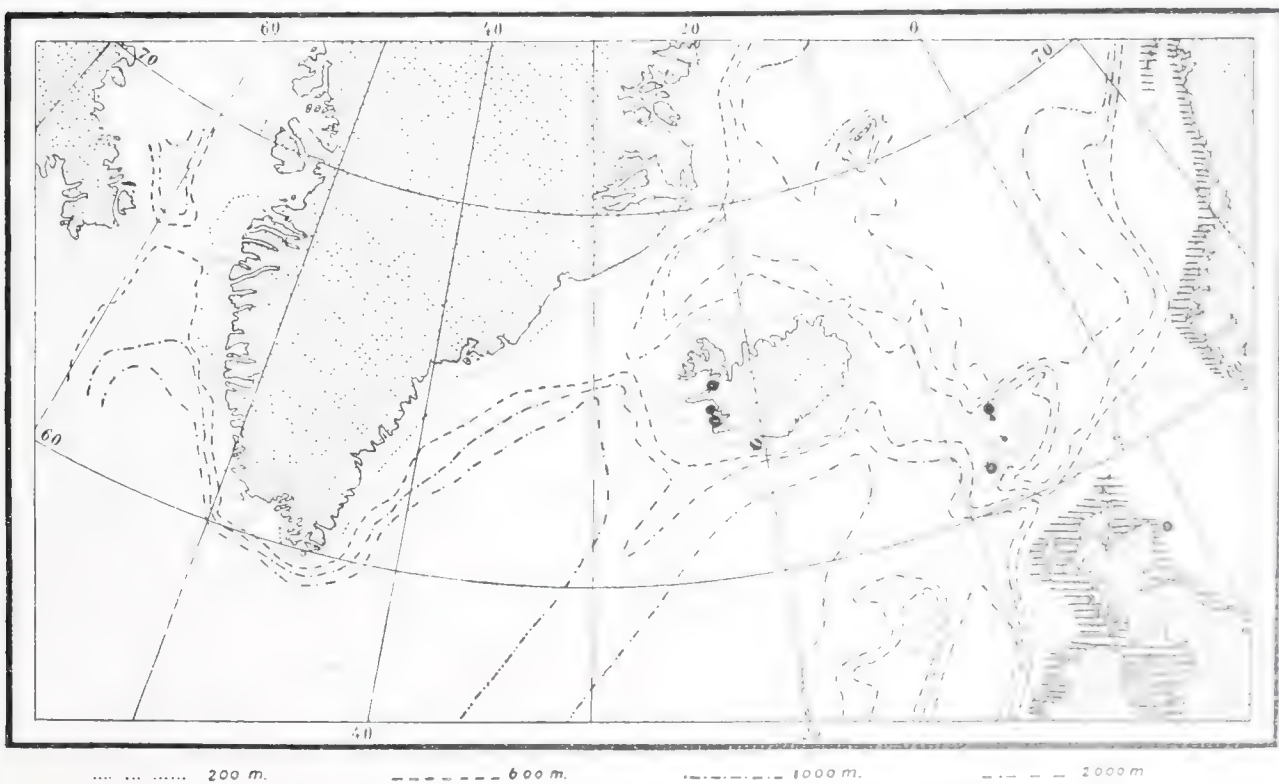


Fig. LXXXVIII. The distribution of *Laomedea gracilis* in the Northern Atlantic.
In the hatched regions the literature notes a scattered occurrence.

monosiphonic main stem, which not infrequently appears to be dichotomously branched. The branches and the hydrotheca stalks are ringed close above their origin, and below the hydrothecæ, otherwise smooth. The hydrothecæ are twice to three times as long as broad, cylindrical, or rather inversely conical, passing over by an evenly curved transition into a short, almost cylindrical basal part; the basal chamber is small, bounded at the top by a fine, well developed diaphragm, often somewhat assymmetrically placed. The hydrotheca margin is provided with seven to fourteen markedly prominent pointed or pointedly rounded teeth.

The gonothecæ are attached by short, ringed stalks proceeding from stem or branches, rarely from the stolons. They are inversely conical or slightly oval, elongated, cut off transversely at the distal end, without neck. The gonophores develop into cryptomedusoid meconidia, projecting from the gonotheca without breaking away. The larval development takes place within the interior of the meconidium (*Gonothyræa* medusæ).

Material:

"Thor" 64°02' N., 22°33' W., depth 34 metres

Iceland: (without further details) on the back of a *Dinematura ferox* taken from a *Somniosus microcephalus*.

Laomedea gracilis is a southern visitor to the northern waters (fig. LXXXVIII) where it penetrates up to the northern point of Norway. The species is altogether of rare occurrence here, but has been taken more especially about the British Isles. One or two finds show that it also occurs sparsely at the Faroe Islands and south-west Iceland, always in the middle or upper third of the littoral region.

Gen. *Bonneviella* (Broch).

Stolonial colonies with enormous, often slightly bilateral hydrothecæ, having a finely built diaphragm. The large polyps can be withdrawn entirely into the hydrotheca. The hydranth has a crown of strong tentacles with multiserial endoderm; the oral part is thin, forming a thin lamella, consisting of two cell-layers, which a little above the tentacle base extend out like a velum in towards the central oral aperture. The tentacle base thrusts itself into the polyp, so that a large proboscoidal cavity is formed between this and the oral aperture. The gastral endoderm is uniformly developed.

As already mentioned, I am unable to agree with Nutting, who is inclined (1915 p. 94) to support the view advanced by me in a former work (1909 p. 197), that the ectoderm covers the tentacle base and the inner side of the velum-like proboscoidal part. Kühn (1913 p. 253) is justified in doubting whether the part in question can be reckoned as belonging to the endoderm, and I am more disposed to follow him here, considering the part as an extreme development of the indifferent endoderm cell-layer, as found for instance on the proboscis of *Campanulariidae*. The point can, however, only be decided by study of the polyp development. The systematic position of the genus is still altogether doubtful.

Bonneviella grandis (Allman) Broch.

1876 *Campanularia grandis*, Allman, Diagnoses of new Genera and Species, p. 259, pl. 12, figs. 2—3.

1899 *Lafoca gigantea*, Bonnevie, Den norske Nordhavs-Expedition, p. 68, pl. 6, fig. 2.

1909 *Bonneviella grandis*, Broch, Hydroidenuntersuchungen, II, p. 198.

The colonies form enormous upright and irregularly branched rhizocaulomes. From the tubes proceed hydrotheca stalks of differing length, often segmented, with a spherical swelling immediately below the hydrotheca. The latter are twice to three times as long as broad, swollen for the lower third part, somewhat narrower above, with expanded margin; in transverse section, the hydrotheca is circular below, oval nearer the aperture; the aperture itself is as a rule somewhat asymmetrical, the margin quite smooth. The basal cavity is small, bounded at the top by a quite thin diaphragm.

The gonothecæ proceed from the tubes of the stem; they are more or less closely set, and occur scattered about all over the colony. The gonothecæ are egg-shaped to spindle-shaped with six to eight longitudinal ribs and a short, narrow trumpet-shaped neck.

Material:

Iceland: 64°17.5' N., 14°44' W., depth 75 meters 5°12

The Faroe Islands: Thorshavn (depth not stated).

The genus *Bonneviella* includes several species from the northern Pacific, for the further description of which we are indebted to Nutting (1915 p. 95). One of these species is *Bonneviella*

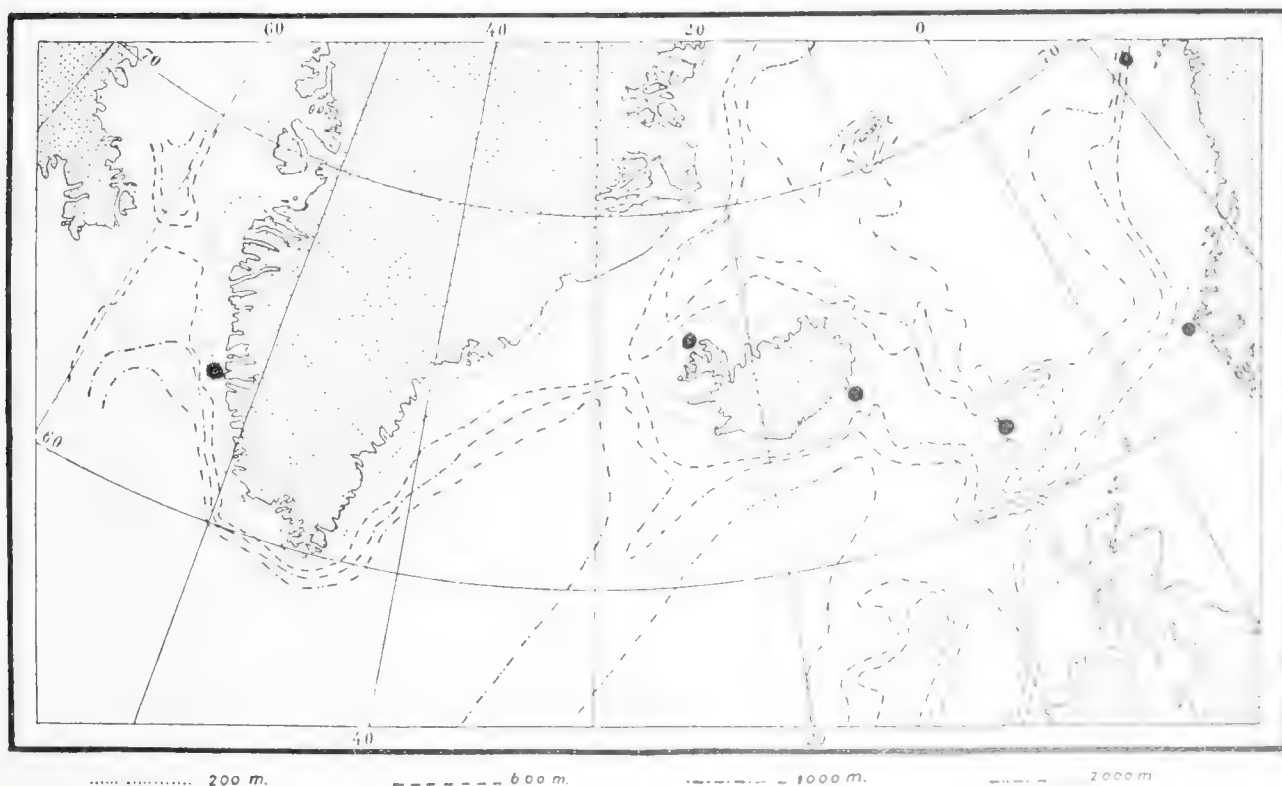


Fig. LXXXIX. Localities of *Bonneviella grandis* in the Northern Atlantic.

grandis, first described from some colonies from Japan, Tsugor Strait, preserved at Copenhagen. The species differs from the others by its longitudinally ribbed gonothecæ; the other species in which the gonangia are known, have the gonothecæ transversely furrowed. The next find of *Bonneviella grandis* was made off the west coast of Norway. We have since learned, that the species, besides occurring at several places in the North Pacific, is also widely distributed in European waters. It has been met with in the Barents Sea, at Lofoten (fig. LXXXIX), at Moldoen near Stat on the west coast of Norway. It is mentioned from the south-east point of Iceland and from Fyllas Banke in Davis Strait. We may now add some new localities; the Faroe Islands, and outside Isafjord, Iceland, where it was taken by the "Michael Sars" in the summer of 1903. *Bonneviella grandis* must thus be characterised as a boreal circumterrestrial species, belonging to the lower parts of the littoral region and the upper portion of the abyssal.

III. Addenda to the Athecate Hydroida.

In going through the athecate hydroids, some few glasses were overlooked, and are here included.

Corymorpha nutans M. Sars (Part I, p. 31).

Iceland: Keflavik (depth not stated)

Bredebugt 65°12,5' N., 23°28' W., depth 36 fathoms.

Corymorpha groenlandica (Allman) Broch (Part I, p. 33).

"Ingolf" St. 15 66°18' N., 25°59' W., depth 330 fathoms ÷ 0,75°

This find forms an interesting complement to the former data (cf. Part I, text fig. I); it lies in Danmark Strait, on the northern slope of the threshold, and shows that the species also occurs between Iceland and Greenland.

Family Branchiocerianthidæ.

Athecate hydroids without calcareous skeleton. The tentacles of the grown polyp, which are all filiform, make two main circles; the tentacles have a central cavity not connected with the gastral chamber. The supporting lamella exhibits no particular development in any of the tentacles. The hydranths are bilateral in structure. At the base of the proximal tentacles, numerous radial canals occur, reducing the mesogloal formations to a minimum. The gastral chamber is divided by a horizontal septum into two parts, a smaller proboscoidal, and a larger basal. The gastral endoderm is homogeneous in both.

Gen. **Branchiocerianthus** Mark.

The polyps are bilaterally symmetrical, the stalk being excentrically attached; the oral aperture also is excentrically situated, being thrust over towards the opposite side of the point where the stalk

is attached. The hydranth has a proximal tentacle crown, the growth of which takes place from the part of the hydranth periphery nearest the stalk, where the shortest tentacles are found. The tentacles of the oral circle are homogeneously developed. The periderm of the stalk is reduced and soft. The blastostyles are situated between the tentacle crowns, the youngest ventrally above the point of attachment of the stalk. The polyps are solitary.

Allman (1888 p. 5) described the first *Branchiocerianthus* species, which was brought home by the "Challenger", under the name of *Monocaulus imperator*. The family *Monocaulidae* had been previously founded by Allman (1871 p. 395) with the following diagnosis: "Hydrocaulus solitary, naked. Hydranths with a proximal and a distal set of filiform tentacles. — Gonophores in the form of fixed sporosacs". This diagnosis thus makes no mention of the essential point, to wit, the bilateral character of the polyp. Nor is any reference to this found under the heading of the only genus, *Monocaulus*, which is thus described:

"Hydranth abruptly distinct from the hydrocaulus; proximal tentacles longer than the distal and disposed in a single verticil near the base of the hydranth, the distal set scattered over a zone close to the summit of the hydranth. — Sporosacs borne upon peduncles, which spring from the body of the hydranth between the proximal and distal sets of tentacles.

The genus *Monocaulus* is constituted for the *Corymorpha glacialis* of Sars, a form which, though its trophosome is that of a *Corymorpha*, is yet strongly distinguished from the true *Corymorphas* by its adelocodonic gonophores" (Allman 1871, p. 396).

In addition to *Corymorpha glacialis*, Allman also places *Corymorpha pendula* L. Agassiz in the genus, this being a species with free medusæ. Later on, *Corymorpha groenlandica* is also placed in the same genus. And here, finally, *Monocaulus imperator* is likewise included, Allman (1888 p. 5) having entirely overlooked the bilateral structure of the species, and disregarding the morphological peculiarities noted in his descriptions.

With reference to *Corymorpha* I have pointed out that Allman's typical *Monocaulus*, *Corymorpha glacialis* M. Sars must remain in the genus where M. Sars placed it, like *Monocaulus groenlandica* Allman, the only species which entirely answers to the diagnosis given by Allman. It would therefore be altogether wrong to follow the suggestion given in "Nomina conservanda" (cf. p. 53) and retain the generic name *Monocaulus* for a genus where *Monocaulus imperator* has been somewhat arbitrarily chosen as type, the more so since the essential feature of the species, which is even characteristic of the genus as a family type, was distinctly emphasised by E. L. Mark in 1899 in his description of the central American Pacific species *Branchiocerianthus urceolus* Mark. Since then, the genus has been referred to in all leading works under the generic name given it by Mark, *Branchiocerianthus*, and as the species in question have been accorded only the briefest mention in the handbooks, there will be no confusion caused by general adoption of the appellation. Moreover, after the publication of the fundamental studies on *Branchiocerianthus* by Mark (1899), Miyajima (1900), and Stechow (1908, 1909) it would certainly be confusing to adopt the name *Mon.*

The genus *Branchiocerianthus* was hitherto only known from the Pacific (Alaska, Japan, Panama) and the Indian Ocean (Beluchistan, Oman, and East Africa). Stechow, in his description of

Branchiocerianthus imperator (1909, p. 71) states: "Da im übrigen die Familie¹ ganz kosmopolitisch ist so dürfen wir wohl annehmen, dass Branchiocerianthus-Arten auch im Atlantischen Ozean vorkommen, bisher aber nur wegen ihres Lebens in grösserer Tiefe noch nicht gefunden worden sind".

Excellent proof as to the correctness of this supposition has now been furnished by the finding of a *Branchiocerianthus* in the deep part of Davis Strait, where it occurs together with other representatives of a southerly deep-sea fauna. Stechow's characterisation of the habitat of the genus as "Kaltwassergebiet" however, is biogeographically erroneous; *Branchiocerianthus* has not yet been met with in the cold area, and is hardly likely to prove a characteristic element in the fauna of that region. The genus belongs to the abyssal region of the warmer seas, or strictly speaking, that portion of the same which makes the home of the "intermediate fauna". The temperature here may certainly fall pretty low in certain places, but is never below 0°. The "Kaltwassergebiet" would include the cold area, where the temperature is constantly below 0°.

Branchiocerianthus reniformis n. sp.

(Pl. I, figs. 2—5).

The hydranth, viewed from below, has a distinctly kidney-shaped appearance, with a deep (ventral) sinus reaching right in to the stalk. Owing to the depth of this incision, the stalk appears comparatively centrally situated, the distance to the dorsal edge (6 mm) being slightly more than that between the stalk and the margin of the disc perpendicular to the dorso-ventral axis (4.5 mm). The oral aperture seems to be somewhat more excentrically placed, being distant between a fourth and a third of the diameter of the disc from the dorsal margin of the disc. The oral aperture is very large, and in the present specimen it is curved over, revealing the highly folded gastral endoderm (Pl. I, fig. 3). It would almost seem as if the margin of the oral aperture were divided into lobes; from the single specimen here available, however, it is impossible to decide with certainty, whether this is natural, or due to accidental damage. The margin of the oral aperture is curled, with a closely packed tentacle crown, showing indications of multiserial arrangement. The oral tentacles are everywhere round in transverse section, and are strongly built. The basal tentacles form a single circle; they are very long, with exception of the ventral ones, which are placed along the margin of the disc in the incision. In the incision itself, the tentacles decrease rapidly in length in towards the stalk, at its base are the youngest tentacles, which are quite small. The basal tentacles are laterally compressed at the base, where they easily fall off; in the present specimen, only the tentacles in the incision and a pair beside it are intact, the remaining ones having fallen away. The stalk of the polyp is thin, longitudinally striped. The short basal part is covered with numerous fine root hairs extremely closely set, forming a tangled mass round the end of the stalk and entirely covering it there. There is no zone of incipient root hair formation discernible above the developed part.

The blastostyles form a crown, interrupted ventrally, about the hydranth between the tentacle crowns, nearer the basal. The blastostyles are closely set in a crown which may be up to triple-rowed. The large blastostyles divide near the base at once into two or three main branches of equal size, which later (Pl. I, fig. 5) again divide dichotomously at intervals two or three times. The top of

¹ I. e. *Corymorpha* and *Branchiocerianthus*.

the blastostyle is shaped rather like a cluster of grapes, the outermost swellings, shown in the figure, consist each of a compact accumulation of incipient gonophores. Nematocyst-bearing terminal buds appear to be altogether lacking. The size of the blastostyles decreases nearest the ventral interval, whence a new formation evidently takes place.

With regard to the anatomical character of the polyp, we must notice the large mesentery which divides the gastral cavity into an upper (oral) and a lower (basal) section; it has a large median opening. The radial canals have a large lumen; they do not appear to divide, and alternate with the tentacles, and thus do not stand in open connection with the latter; their number corresponds to that of the proximal tentacles. — The blastostyles are hollow, and communicate openly with the interior of the polyp, but it was impossible to determine exactly whether their communication with the gastral cavity is direct, or proceeding indirectly through the radial channel.

Material:

“Ingolf” St. 28 65°14' N., 55°42' W., depth 420 fathoms, 3,2°.

The only specimen procured presents the following features: Total length 120 mm., of which 110 mm. fall to the hydrocaulus. Distal diameter of the stalk 3 mm., close above the root hairs the transverse section is 7 mm. The polyp disc has a total breadth of 12 mm. and a length of 9 mm., measured from the bottom of the ventral incision. There are 85 proximal tentacles; the longest of those intact is 55 mm. The distal tentacles are very closely set, often displaced, giving a slight indication of three rows; there are between 80 and 90 oral tentacles of up to 5 mm. length. The blastostyles are closely packed together, and form three indistinct rows, the longest is 4 mm.; there are between 70 and 80 in all.

On comparing the present specimen with the species of *Branchiocerianthus* previously described, we find several points of difference, albeit none very striking in itself. The peculiar kidney-shaped appearance of the disc (Pl. I, figs. 2 and 3), as also the curled margin of the oral aperture, would seem to be different from the species previously described, and has led me to regard the specimen for the present as representing a distinct species, *Branchiocerianthus reniformis*. The lack of terminal buds bearing nematocysts in the blastostyles brings the species near to *Branchiocerianthus* n. sp. Stechow, (1913 p. 54) from which, however, it is immediately distinguished by its undivided radial canals. The habitus of the hydranth distinguishes it from *Branchiocerianthus urceolus* Mark; this may, however, possibly be taken as due to a difference in the state of contraction. From *Branchiocerianthus imperator* (Allman) again, the species differs in the lack of nettle buds on the blastostyles. From the appearance of the specimen in 1904, *Branchiocerianthus reniformis* has also a different colour; the body of the polyp was then white, the blastostyles being a deep violet blue; now, after having lain many years in alcohol, it is an even grey.

The individual can hardly be fully grown, and corresponds in point of size only with the smaller specimens of *Branchiocerianthus urceolus* found. The number of proximal tentacles agrees mainly with that in this species, but there are far fewer distal tentacles; save for one of Allman's specimens of *Branchiocerianthus imperator* (1888) all the other individuals found belonging to this genus had considerably more distal tentacles. The number of blastostyles takes up an intermediate place between the two mentioned species, and is somewhat lower than in *Branchiocerianthus* n. sp.

Stechow (1913). As, however, the specimen is unique, and moreover, apparently not fully grown, these points should not be considered as of too great importance in the present state of our knowledge. For the present, it will be most correct to regard the specimen as representative of a distinct species, bearing in mind, however, that subsequent investigations may possibly show it to be identical with one of those formerly described.

Branchiocerianthus reniformis will probably, as the find suggests, prove to belong to the abyssal region. Its occurrence shows that the genus is of circumterrestrial distribution.

IV. Zoogeographical observations on the Hydroid Fauna of the North Atlantic.

The study of the bathymetrical distribution among hydroids still leaves much to be desired; the data on record are still somewhat scanty, and merely suffice to give an occasional glimpse of the regularity which will doubtless be found to prevail throughout this animal group, just as in others. It has been a generally accepted notion, and is so to some extent even now, that a marine animal species with a wide horizontal distribution will prove of shallower occurrence the farther north it is found in our waters, or rather, the farther it penetrates into the cold areas. This rule, however, is not universally applicable. True, we find that species which must be regarded as more or less arctic are met with in more southerly tracts in the deeper water-layers, but on the other hand, warm atlantic character forms which are found farther south up in the littoral region often exhibit, in the few northern finds made, a tendency to prefer even much greater depths. Evidently then, the biophysical conditions here approach more nearly to those prevailing in the southern home of the species, though we cannot at present find any further explanation of this. At any rate, the question is seen to be a good deal more complicated than was at first supposed, and the available data are unfortunately far from sufficing to give a thorough exposition of the biogeography in hydroids in the northern waters.

In this connection, it will not be out of place to explain one or two expressions which are constantly recurring when dealing with the different species. I refer to the terms littoral and abyssal region. I have followed the general international acceptance in using "littoral region" for the upper 3—400 metres of the sea floor, "abyssal region" for depths beyond. It is true that certain northern writers have sought to give the terms in question new and sometimes quite different meanings. This, however, gives rise to confusion, and further complicates the still somewhat new field of research known as biogeography. The terms used should be as nearly as possible invariable, and should not require to be defined anew by each writer, as has hitherto been the case. Indeed, it might almost seem well to discard altogether the term littoral region, since it appears to be interpreted in almost as many different senses as there are writers in Scandinavia. I have here, however, as indicated, employed the expression in the general sense in which it is used outside the works of the scientists referred to.

A great majority of the northern hydroids are decidedly inhabitants of the littoral region, and among these we find a number of species which characterise its upper part, the tidal zone. This zone comprises, on open sea coasts, the belt between high- and low-water marks; in fjord grounds, however, where the water is mixed with fresh, we are obliged, on account of the altered hydrographical conditions, to draw the lower limit somewhat farther down, where the laminariæ begin. The tidal zone is in all parts of the northern waters characterised by Fucoids, and is distinguished in hydrographical respects by its rapidly and widely fluctuating temperature and salinity. Certain writers have objected to the validity of this zone as such, on the ground that all its character organisms are also normally to be met with deeper down; this, however, merely reveals a lack of knowledge as to the true state of the case. We may in the first instance take a species which has been utilised in several works for giving the zone in question its other name; to wit, *Balanus balanoides* Linné. This species does not normally penetrate deeper down. In this connection, however, we are naturally more interested in the characteristic hydroids; which are: *Coryne pusilla*, *Clava multicornis* and *Laomedea flexuosa*. These species are altogether restricted to the tidal zone, and their occurrence in deeper water in the open sea must be regarded as an anomaly, unless due to erroneous identification on the part of the investigator. It is likely that also other species, especially certain *Coryne*, should be grouped among the character forms of the tidal zone, but we have not yet sufficient data to assert this as a fact. The mentioned species are so completely restricted to the area in question, — which is not rich in species on the whole — that we are fully justified in distinguishing the tidal zone as a separate area with a fauna of its own.

The deeper zones are, from the character of the investigations, somewhat less strictly defined. It would nevertheless seem that species such as *Eudendrium Wrighti*, *Sertularella rugosa*, and *Laomedea geniculata* are altogether restricted to the Laminaria zone, while *Dynamena pumila* is common to the shallower part of this zone and the tidal zone. The great bulk of the hydroids commence to appear in the lower parts of the laminaria zone, reaching their most luxuriant occurrence in the red alga zone and the lower parts of the littoral region.

On passing down beyond about 600 metres depth, however, the lower limit of what may be called the "coast bank region", we encounter a sudden and very marked decrease in the number of hydroids; below this limit, their occurrence must be called more sporadic, and there are only a few unique species which have their chief occurrence at greater depths. The deep-sea species in question, which have their habitat down here, exhibit also, in each case, a merely sporadic occurrence, — though we cannot, of course, entirely disregard the possibility that this apparent state of things may in reality be due to lack of sufficiently exhaustive investigations in the proper localities. A clear indication of the inadequacy of our knowledge as to these deeper parts of the sea floor, even in the North Atlantic, is afforded by the "Ingolf" expedition's unexpected finding of species such as *Branchiocerianthus reniformis*, *Zygophylax biarmata*, *Grammaria conferta*, *Polyplumaria profunda*, and *Sertularia amphorifera* close south of the submarine ridges in Davis Strait, Danmark Strait, and between Iceland and the Faroe Islands.

With the paucity of available material, it is of but little interest to go into details regarding the bathymetrical distribution of the species. On the other hand, it is well worth while to consider

the extent of certain horizontal areas of distribution, and we may first of all endeavour to obtain a clearer idea as to what is commonly known as the boreal region, the definition of which at times appears to be somewhat vague. In the case of the hydroids, the data on record furnish valuable hints, as will be seen from the following.

Theoretically speaking, the northern limit of the boreal region should be drawn as the boundary where southern species of general occurrence in northern waters cease their northward progress, while similarly, the southern limit should mark the extreme margin of the arctic-boreal species' distribution. It should, moreover, constantly be borne in mind that the boreal area is decidedly a "mixed"

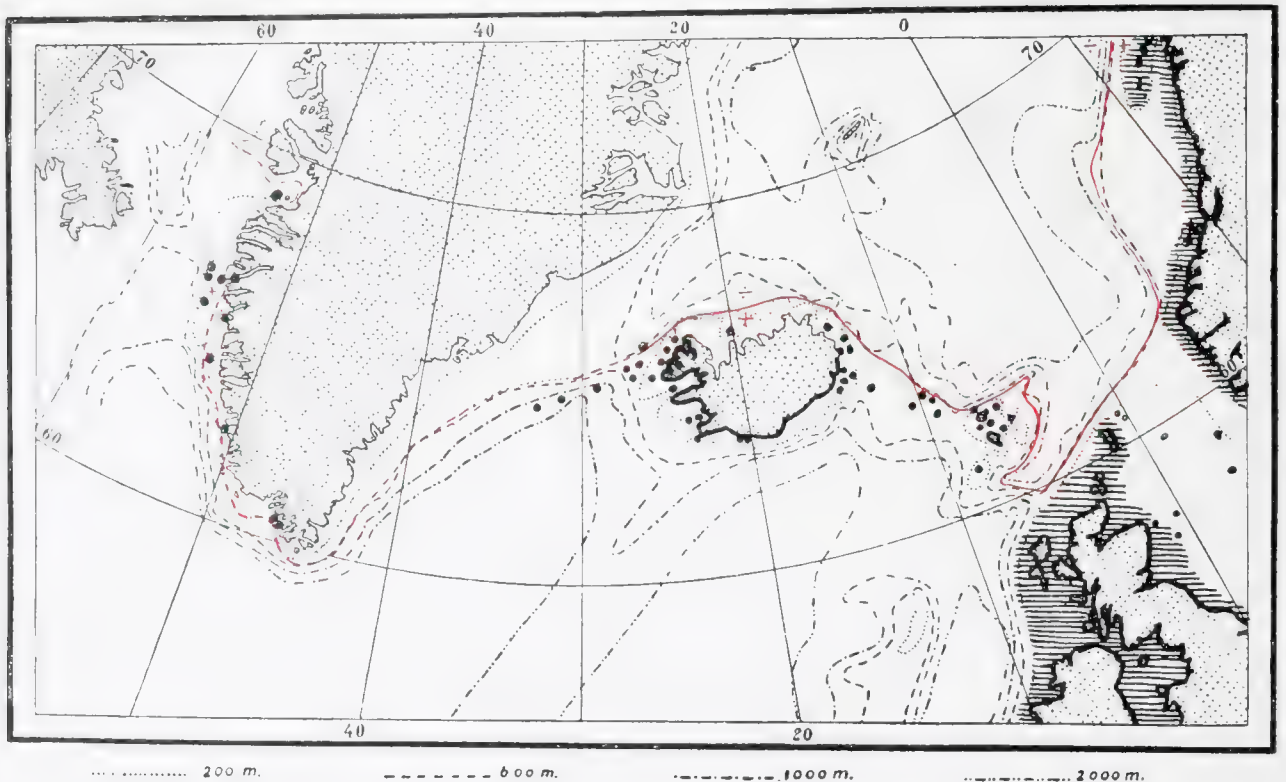


Fig. XC. The occurrence of *Nemertesia antennina*, *Dynamena pumila*, and *Thujaria thuja*, three species which are common in more southern European waters, but which only have been found in high arctic waters quite exceptionally. (The red line approximately indicates the limit of the cold area).

area; strictly boreal species are extremely few in number, among hydroids as among other animal groups, and will in many places penetrate out beyond the limits of the narrower region. — As examples of southern species extending up to the frontier of the arctic areas we may take for instance *Nemertesia antennina*, *Dynamena pumila*, and *Thujaria thuja*. These three are practically never found in true arctic waters; where finds have been made, it was always at places where north-going currents render the limits uncertain, or where the varying conditions of the coastal water afford southern species a precarious refuge in some isolated spot within the arctic seas. At such places we may encounter, for instance, scattered colonies of *Dynamena pumila*. As a general rule, we find (fig. XC) that these species do not cross beyond the limit of the cold area as indicated by the course of the 0° isotherm. At the same time it should be noted that the mentioned species are by no means infre-

quently met with in Davis Strait, which is thus proved to belong, at any rate in part, to the boundary waters of the boreal region. Yet the species penetrate only quite exceptionally into the west Greenland fjord area, which must be regarded as purely arctic, partly on account of the intermixture of melting water from the glaciers, and partly owing to the north-going branch of the East Greenland Polar Current, which turns round Cape Farewell and runs some distance up the coast. Here we still find *Dynamena pumila* sporadically, probably because the investigations were carried out at a time when the summer heat had brought the surface temperature up a little, enabling the species just to exist for a brief while, and under difficulties. Not until we reach the waters between Holstensborg

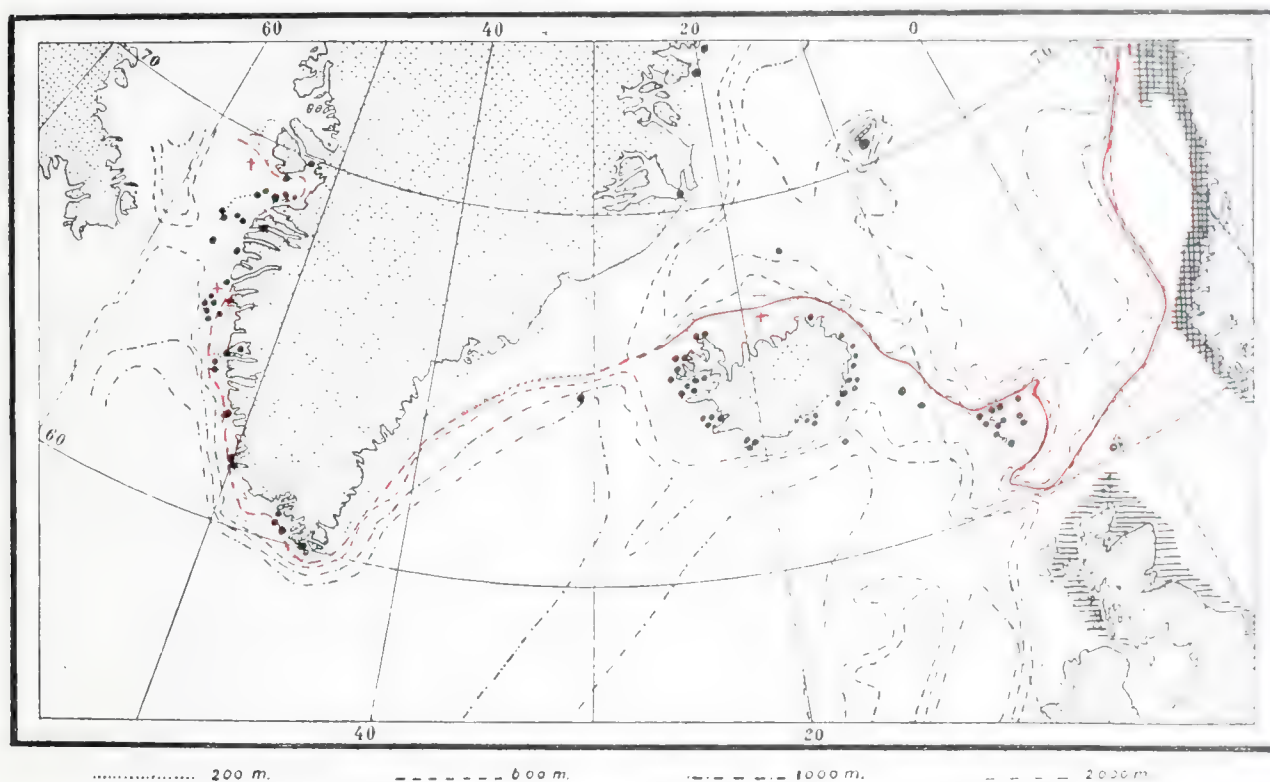


Fig. XCI. The occurrence of *Halcium muricatum*, and *Sertularella tricuspidata*, two arctic species which penetrate into the southern parts of the boreal region. (The red line approximately indicates the limit of the cold area).

and Egedesminde do the boreal elements in the coast fauna become more pronounced. In Denmark Strait, between Greenland and Iceland, we see that the finds group themselves closer as soon as we pass south of the 0° isotherm, where the depth conditions are more favourable. Despite their positive bottom temperature, the shallower North-Icelandic waters seem to take a more arctic character, though this may, as we shall presently see, perhaps be equally well explained as due to insufficient investigation. Between Iceland and the Faroe Islands, the species move up to the verge of the cold area, but do not pass it. And the whole of that part of the Norwegian coastal banks which falls within the limits of the chart presents an entirely boreal character.

Turning now to the other side, and taking the distribution of the arctic-boreal species *Halcium muricatum* and *Sertularella tricuspidata*, several peculiarities are also here apparent (fig. XCI)

Both species occur in Davis Strait, very commonly on both sides of the 0° isotherm, but do not go deeper down from the coastal banks. Both, however, are apparently entirely lacking along the east coast of Greenland south of 76° N. This may be due to paucity of investigations, but it would seem likely that the reason is rather to be sought in the fact that the water, owing to extensive intermingling of fresh and ice-cold glacier water is poor in suitable forms of nourishment, and unfavourable to the growth of hydroids generally. Altogether, only a very few hydroids have been found along the range in question, the finds in question invariably consisting of but few and small colonies. The apparent absence of the mentioned species in North Iceland waters, on the other hand, would seem

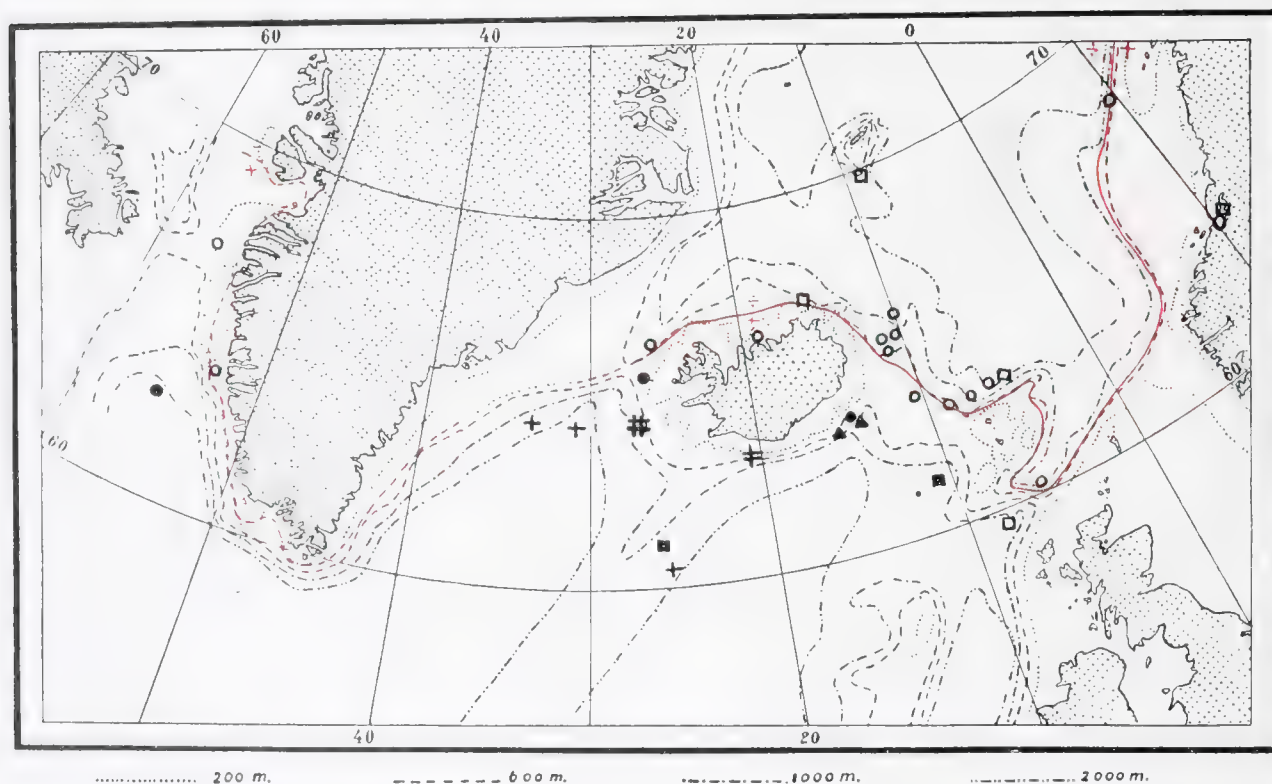


Fig. XCII. Localities of the arctic deep sea species *Myriothele phrygia* □, and *Corymorpha groenlandica* ○, and of the southern, exotic guests *Grammaria conferta* +, *Zygophylax biarmata* †, *Polyplumaria profunda* ●, *Cladocarpus Diana* ■, *Sertularella amphorifera* ▲, and *Sertularia(?) tubuliformis* ‡. (The red line approximately indicates the limit of the cold area).

rather to be due to lack of sufficient investigation; it is difficult to find any other explanation. The frequent occurrence of the species round all the remainder of Iceland's coast shows that the range in question must as a whole be included in the boreal area; there is no indication of warmer tendency at any place on the true coastal banks here. The ridge between Iceland and the Faroe Islands, and the waters round the latter down to 600 metres' depth must be taken as belonging to the boreal region, as also the western Scottish waters. The North Sea also is boreal, and the Norwegian coast to the extent shown on the chart.

Before concluding this characterisation of the boreal area, two other geographical groups of less frequently occurring hydroids should be considered. These are the deeper-living inhabitants of the cold area, represented by *Myriothele phrygia* and *Corymorpha groenlandica*, and the exotic warm-

water species of the Atlantic, found here and there in the waters investigated (fig. XCII). *Myriothele phrygia* is apparently an easterly arctic species which penetrates out to the southern limit of the cold area; it has in a single instance been taken on the southern, deep slope of the Wyville-Thomson Ridge, brought thither probably by larval transportation. *Corymorpha groenlandica* moves out everywhere to the boundary, and has once passed beyond it, in Davis Strait, on the Store Hellefiskebanke, and between Iceland and the Faroe Islands, probably likewise as a result of larval transportation. Both species are, moreover, met with in a single isolated spot far up in the boreal region, to wit, in Trondhjem Fjord, where they must probably be regarded as relicts — The opposite group, the exotics, will be represented by *Grammaria conferta*, *Zygophylax biarmata*, *Polyplumaria profunda*, and *Sertularella amphorifera*. One or two of them may in southern localities exhibit a shallower occurrence; here in the north, however, save for a single find of *Polyplumaria profunda* up in Danmark Strait, they are not met with beyond the 600 metre curve, nor within the true boreal region.

A study of the hydroids leads then to the result, as seen from the instances given, that the limits of the boreal zone as against northerly or arctic waters must be drawn along the 0° isotherm; to the south by the southern side of the ridges along the 600 metre curve. The boreal region extends thus from far up in Davis Strait, where, however, it extends only in a very few places in to the coast of West Greenland, across the highest part of the submarine ridge into Danmark Strait, round the coasts of Iceland, including also the plateau between Iceland and the Faroe Islands, the Faroe Islands Banks, the western Scottish waters, and the North Sea and the Norwegian coast plateaus (vide charts). Practically speaking, the region embraces all the coast banks of the waters investigated, down to 600 metres, save for the upper 200 metres of the Greenland banks.

On comparing the results here arrived at with the lines laid down in Appellöf's¹ and v. Hofsten's^{2,3} fundamental works on Crustacea and Echinoderms, we find that they agree very closely therewith. We have, however, here disregarded the mixed areas, which in the works referred to are strongly emphasised. The "boreo-arctic" area, where arctic and boreal elements appear in equal proportions, should strictly speaking doubtless comprise the upper parts of Store and Lille Hellefiskebanke, possibly also Fylla Banke, West Greenland, while the north Icelandic coastal region likewise seems to belong to the same. The second mixed area, which according to Appellöf includes the southern parts of the North Sea, the English Channel, and the Irish Channel, should be characterised by a very marked intermixture of southern, Lusitanian or Mediterranean species.

It has previously been pointed out that hydroids only penetrate in small numbers down beyond 600 metres depth. It might therefore be objected that the southern boundary of the boreal region as against the Atlantic will in the case of other animal groups be found to follow a deeper curve than here indicated. In comparison therefore, we should also include arctic-boreal species of other animal groups which are more eurybathic. It will here suffice to refer to v. Hofsten's charts for *Amblopeten sericeum* and *Spirontocaris Gaimardii*; they show the same features as the corresponding hydroid species, and the same southern limits for the boreal region at about 600 metres' depth.

¹ 1906, Die dekapoden Crustaceen. Meeresfauna von Bergen, Heft 2 und 3. Bergen.

² 1915, Die Echinodermen des Eisfjordes. Zoologische Ergebnisse der schwedischen Expedition nach Spitzbergen 1908. Teil II. Stockholm.

³ 1916, Die dekapoden Crustaceen des Eisfjordes. Ibid. Teil II. Stockholm.

One risk attaching to the insertion of the mentioned boreo-arctic and Lusitanian mixed areas lies on the one hand in the fact that by such further division, the whole arrangement is rendered less easy to survey and handle. If, however, other and more essential advantages were procured by so doing, we should naturally not hesitate to accept the biogeographical sub-areas in question. But here a very serious difficulty makes itself felt, more particularly on considering the group of hydroids as a whole, to wit, the question of how far up in the boreal area — *sensu* laterior — the intermixture of southern elements takes place to such a degree that the waters concerned should be regarded as a mixed area. By way of illustration we may take the distribution of the families *Plumulariidae*

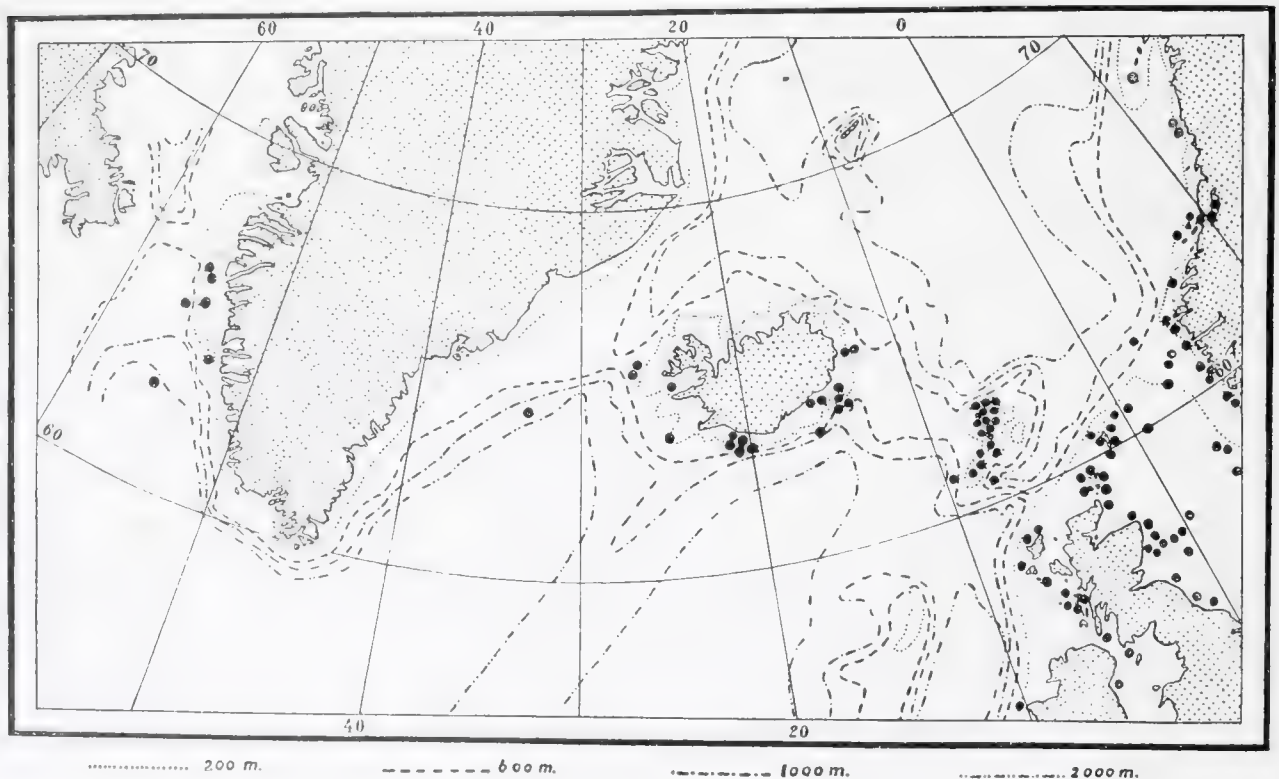


Fig. XCIII. Finds of *Plumulariidae* in the Northern Atlantic.

and *Aglaopheniidae*, the members of which without exception have their chief occurrence in warmer and more southerly waters, and must in the boreal region be regarded as southern visitors, even though some few of them, such as *Nemertesia antennina*, and *Kirchenpaueria pinnata*, may here and there occur in considerable numbers. We should note then, that *Plumulariidae* (fig. XCIII) which save for one or two exceptions belong to the upper 300 metres, are found — and found very frequently — in the North Sea and along the west coast of Norway, including the Trondhjem Fjord, round the Faroe Islands, along the east, south and west coasts of Iceland; indeed, several species have even been met with several times on the boreo-arctic Lille Hellefiskebanke in Davis Strait. Judging from the family *Plumulariidae* then, we come to the result that the Lusitanian element plays a very prominent part in the heart of those areas which we have hitherto designated as the boreal; so much so indeed, that it would be necessary to place the greater part of the tracts concerned in the boreo-lusitanian mixed area, if we were to follow Appellöfs principles to their logical conclusion. Taking now again the

family *Aglaopheniidae* (fig. XCIV) we must first of all bear in mind that we are here dealing with the hydroid family which contains most true deep-sea species, so that we get a picture essentially different from the previous one. Yet there are also various resemblances observable. The boreal bottom region is, as will be evident from the foregoing, a restricted part of the typical coast bank region which runs down to about 600 metres depth. Up in this region, *Aglaopheniidae* penetrate more rarely, but are yet not infrequently met with in the North Sea and along the coast of Norway, and may even in certain places be character forms, as for instance in the deep parts of the Trondhjem Fjord, where there is much current. The numerous finds group themselves about the Wyville-Thom-

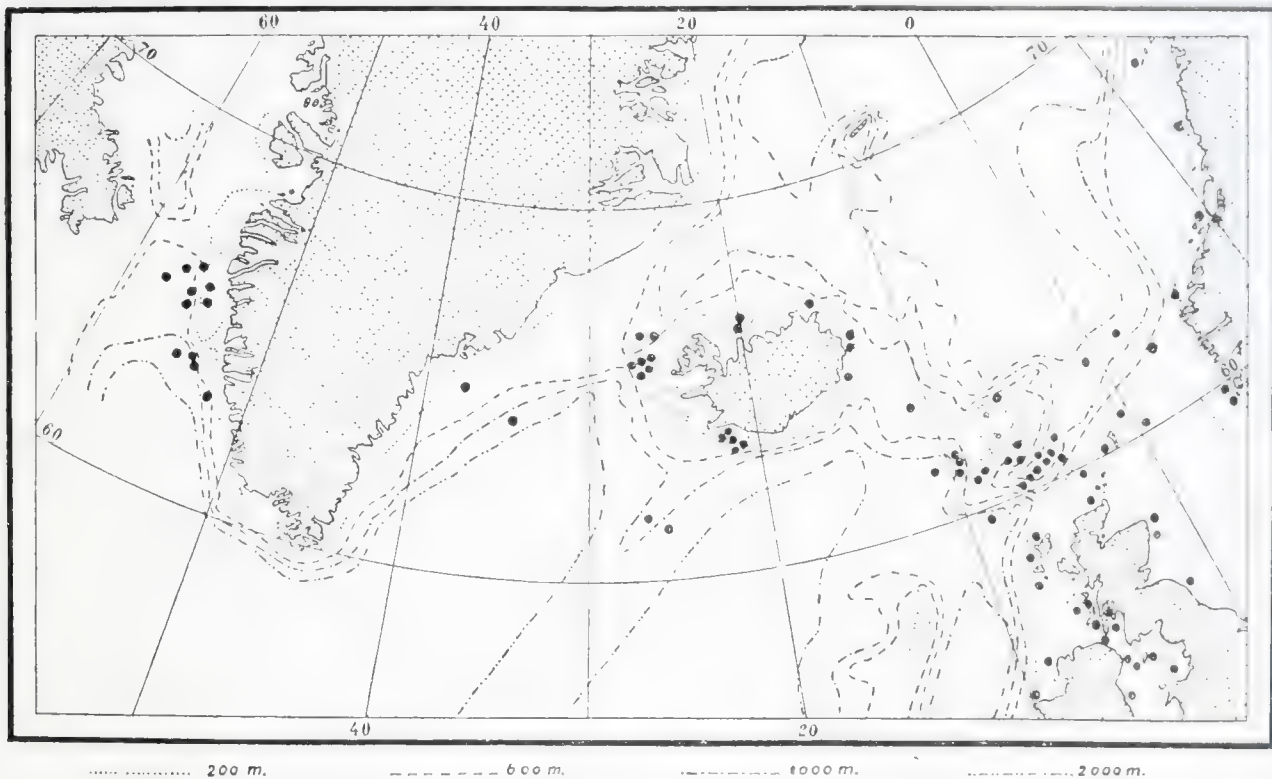


Fig. XCIV. Finds of *Aglaopheniidae* in the Northern Atlantic.

son ridge, and of these, about half lie, mirabile dictu, down in that part of the cold area which juts out into the Faroe Channel. In Danmark Strait, also, the finds are gathered about the top of the threshold, and distribute themselves from here round the north side of Iceland. In Davis Strait, the finds are closest in the north-eastern part of the cul de sac running from the Atlantic Deep up the western side of Greenland to the north side of Lille Hellefiskebanke. In this manner then, the intermediate parts between the aforementioned areas, where the strong intermixture of *Plumularia* sets its mark on the fauna, are levelled out. And to be entirely consistent, we should perhaps also in the Faroe Channel, include a lusitano-arctic mixed area.

The data here given serve to show that the establishment of the mentioned mixed areas, the boreo-arctic and the boreo-lusitanian, is attended by considerable drawbacks. No boundary of any region, of course will ever be perfectly clear and sharp, especially in the case of bottom forms. There are too many factors to be considered, with the result that the frontier as a matter of fact comes to

consist of a more or less broad belt, and such belts or mixed areas may under special circumstances attain relatively considerable extent, while in other places they may be quite narrow. We must also remember that the boreal region in itself is the mixed area par excellence, and has practically not a single species to itself, which makes it even more difficult to say what mixture percentage should be taken as limiting the extra mixed areas, the boreo-arctic and the boreo-lusitanian. The maintenance



Fig. XCV. Currents of the Norwegian Sea (after Nansen and Helland-Hansen).

of these will as a matter of fact be to some extent a matter of arbitrary preference.

The factors exerting principal influence in the formation of the mixed areas are the positive transportation and the passive restriction of the attached organism to the spot once adopted. The latter factor presents no difficulty; if a hydroid colony has once settled down at a given spot on the bottom, then it cannot change its situation, even though the conditions under which it is there called upon to live prove unfavourable. A submarine wave may have produced suitable conditions at the time of attachment, after which a change for the worse sets in. If the colony manages to thrive in spite of this, it will then depend on its propagation whether the species becomes indigenous or not. It is probably the question of propagation which has prevented *Plumulariidae* and *Aglaopheniidae* from becoming indigenous in the Norwegian Sea area; save for a few species, they must evidently be

constantly recruited from without. This renewal takes place in the case of certain species, which lack suitable active motive apparatus, by passive transportation. The transport of grown colonies is here practically speaking out of the question; these animals, we know, attach themselves normally to the sea bottom itself, or to other colonies already attached thereto. It is therefore larval transportation which plays the chief part¹. How long the larval development takes in these forms before they attach themselves to the bottom we do not know; probably the time varies,² being doubtless dependent on external physical conditions; under certain circumstances it would seem that it may extend over a considerable period.

¹ Høf 1905. Havbundens Dyreliv, Norges Fiskerier I, Norsk Havfiske. Bergen p. 114.

The explanation of the distribution in these two families must therefore be sought in the current conditions, and we here obtain a very good idea in the case of *Aglaopheniidae*. The currents in Davis Strait have as yet been only very little investigated, but we know that there is an atlantic current moving up from the deep towards Store Hellefiskebanke and thus depositing larvæ in the cul de sac before mentioned. In the case of the Norwegian Sea, the currents are better known. On glancing at the chart (fig. XCV) and comparing it with the occurrence of *Aglaopheniidae*, the solution is at once apparent. An atlantic current runs northward in the eastern part of Danmark Strait and sends a branch thence along the north side of Iceland and then southward along the east coast; this branch will thus carry larvæ from Danmark Strait and deposit them here and there along the coastal banks north and east of the island, where some few of them are able to develop further. This at once explains the scattered occurrence of *Aglaopheniidae* in these waters. The main force of the northgoing atlantic current, however, is concentrated in the Faroe Channel, and here carries the larvæ in over the Wyville-Thomson ridge. Along the north side of this ridge, then, we find the heaviest "rain" of exotic larvæ in the Norwegian Sea, and here also the greatest percentage of individuals probably capable of developing further, provided they can stand the immersion in the icy waters of the cold area at all. A branch of the same current runs southward along the east coast of Scotland and England, causing a scattered occurrence of *Aglaopheniidae* able to develop in shallower water, such as species belonging to the genera *Aglaophenia* and *Thecocarpus*. Other larvæ drift farther on with the main current, and sink to the bottom on the Norwegian coast plateaus, or the edges of the same, or are occasionally carried as far up as Spitzbergen, whence several finds of *Aglaopheniidae* have been recorded, where offshoots from the Atlantic current break in over the plateaus in the shallower Murman Sea.

It would be of no value here to group the species investigated according to the separate geographical categories. Such arrangement has been made several times in recent works by Kramp (1914) and myself (1909 and later works). It should merely be pointed out that purely boreal hydroids are extremely rare, if indeed we can, after exhaustive investigation, maintain any such at all.

We may now proceed to a closer comparison of the hydroid fauna as it appears in the areas represented by Greenland, Iceland and the Faroe Islands. With regard to the two first-mentioned areas, surveys have recently been published by Kramp (1914), and Sæmundsson (1911); the latter, however calls for certain corrections, and there are also some few additions to be made.

Of the species here dealt with, the following have been met with in West Greenland waters (species new to the area are indicated by a *).

* <i>Coryne Loveni</i>	<i>Monobrachium parasitum</i>	<i>Eudendrium annulatum</i> .
<i>Myriothele phrygia</i>	* <i>Hydractinia Sarsii</i>	— <i>capitata</i>
<i>Tubularia indivisa</i>	— <i>echinata</i>	<i>Lafica dumosa</i>
<i>Corymorpha groenlandica</i>	* <i>Perigonimus abyssi</i>	—
* <i>Branchiocerianthus reniformis</i>	— <i>rosceus</i>	— <i>gracilis</i>
? <i>Clava multicornis</i>	<i>Eudendrium rameum</i>	<i>Trichopora</i>

* In the previous chapters the name has erroneously been spelt *Lafica*

<i>Grammaria serpens</i>	<i>Halecium minutum</i>	<i>Abietinaria abietina</i>
* — <i>conferta</i>	* <i>Polyplumaria profunda</i>	— <i>filicula</i>
— <i>abietina</i>	<i>Nemertesia antennina</i>	<i>Sertularia tenera</i>
— <i>immersa</i>	* <i>Polynemertesia gracillima</i>	— <i>Fabricii</i>
<i>Lictorella pinnata</i>	<i>Aglaophenopsis cornuta</i>	— <i>mirabilis</i>
<i>Stegopoma plicatile</i>	* <i>Cladocarpus integer</i>	<i>Thujaria thuja</i>
<i>Cuspidella humilis</i>	— <i>formosus</i>	— <i>laxa</i>
<i>Lafoëina maxima</i>	<i>Thecocarpus myriophyllum</i>	— <i>alternithecæ</i>
<i>Campanulina turrita</i>	<i>Sertularella tamarisca</i>	<i>Campanularia volubilis</i>
<i>Calycella syringa</i>	— <i>tricuspidata</i>	— <i>verticillata</i>
<i>Tetrapoma quadridentatum</i>	— <i>polyzonias</i>	— <i>groenlandica</i>
* <i>Halecium scutum</i>	— <i>rugosa</i>	— <i>speciosa</i>
— <i>curvicaule</i>	— <i>tenella</i>	<i>Campanularia integra</i>
— <i>muricatum</i>	<i>Diphasia fallax</i>	<i>Laomedea longissima</i>
— <i>labrosum</i>	— <i>Wandeli</i>	— <i>hyalina</i>
— <i>tenellum</i>	<i>Dynamena pumila</i>	<i>Bonneviella grandis</i>

By comparison with Kramp's list (1914) it must be noted, that the following species are synonyms:

<i>Garveia groenlandica</i>	}	<i>Perigonimus roseus</i>
<i>Perigonimus roseus</i>		
<i>Halecium Beani</i>		<i>Halecium scutum</i>
<i>Plumularia groenlandica</i>		<i>Polynemertesia gracillima</i>
<i>Cladocarpus Holmi</i>		<i>Cladocarpus integer</i>

New to the area are thus in reality only the five species *Branchiocerianthus reniformis*, *Hydractinia Sarsii*, *Perigonimus abyssi*, *Grammaria conferta* and *Polyplumaria profunda*.

Of East Greenland species, the material contains the following:

<i>Tubularia regalis</i>	<i>Calycella syringa</i>	<i>Diphasia fallax</i>
* <i>Perigonimus abyssi</i>	<i>Tetrapoma quadridentatum</i>	<i>Abietinaria abietina</i>
* — <i>roseus</i>	<i>Halecium curvicaule</i>	<i>Sertularia tenera</i>
<i>Eudendrium ramcum</i>	— <i>muricatum</i>	<i>Hydrallmania falcata</i>
<i>Lafoëa fruticosa</i>	— <i>labrosum</i>	<i>Thujaria thuja</i>
— <i>gracillima</i>	— <i>tenellum</i>	— <i>laxa</i>
<i>Toichopoma obliquum</i>	— <i>minutum</i>	<i>Campanularia volubilis</i>
<i>Grammaria serpens</i>	* <i>Cladocarpus integer</i>	— <i>verticillata</i>
— <i>abietina</i>	<i>Sertularella tricuspidata</i>	— <i>groenlandica</i>
— <i>immersa</i>	— <i>polyzonias</i>	— <i>integra</i>
<i>Cuspidella humilis</i>	* — <i>tenella</i>	<i>Laomedea longissima</i>
<i>Lafoëina maxima</i>		

Taking into consideration the above noted synonyms, only three species are new to the area, viz: *Halecium labrosum*, *Cladocarpus integer* and *Sertularella tenella*. It should here further be noted that the new investigations have especially augmented the number of species south of 70° N. The East Greenland waters between 60° and 70° N. seem to be very poor in hydroids, even right out on the slope towards the deep of the Frozen Sea, and the Atlantic deep.

According to Kramp (1914) there are hitherto recorded 88 hydroids from Greenland. In the previous sections we have pointed out the following synonyms, which are given in the mentioned list:

<i>Corymorpha groenlandica</i>	}	= <i>Corymorpha groenlandica</i>
— <i>islandica</i>		
<i>Perigonimus roscus</i>	}	= <i>Perigonimus roscus</i>
<i>Garveia groenlandica</i>		
<i>Halecium Beani</i>		= <i>Halecium scutum</i>
<i>Lafœa fruticosa</i>	}	= <i>Lafœa fruticosa</i> , forma <i>genuina</i> and forma <i>grandis</i>
— <i>pocillum</i>		
— <i>grandis</i>		
<i>Sertularia polyzonias</i>	}	= <i>Sertularia polyzonias</i> , forma <i>typica</i> and forma <i>gigantea</i>
— <i>gigantea</i>		
<i>Plumularia groenlandica</i>		= <i>Polynemertesia gracillima</i>
<i>Antennularia antennina</i>		= <i>Nemertesia antennina</i>
<i>Cladocarpus cornutus</i>		= <i>Aglaophenopsis cornuta</i>
— <i>Holmi</i>		= <i>Cladocarpus integer</i>

This means, then, a reduction of five in the number of species. On the other hand, the five new species from the West Greenland area are entirely new to the fauna, so that the number of species is still 88, or, taking *Lafœa fruticosa* forma *grandis* and *Sertularella polyzonias* forma *gigantea* as distinct species, the number is increased to 90. The recent studies have thus not greatly increased the number of species, nor was this to be expected. The greatest increment of species new to the fauna was to be expected in Davis Strait, and the few investigation stations made there by the "Ingolf" are entirely covered by the later expeditions with the "Tjalfe", the excellent treatment of which material has contributed in an essential degree to our comparatively close knowledge of the hydroid fauna in West Greenland waters.

Passing on now to the fauna area of Iceland, we find in the material the following species belonging to this section:

<i>Corync Sarsii</i>	<i>Corymorpha nutans</i>	<i>Bougainvillia confusa</i>
* — <i>pusilla</i>	— <i>glacialis</i>	<i>Eudendrium rameum</i>
<i>Myriothele phrygia</i>	* — <i>groenlandica</i>	
<i>Tubularia pulcher</i>	* <i>Clava multicornis</i>	— <i>capillare</i>
— <i>indivisa</i>	* <i>Hydractinia Sarsii</i>	<i>Lafœa dum</i>
— <i>larynx</i>	— <i>echinata</i>	— <i>fruticosa</i>

<i>Lafæa gracillima</i>	<i>Nemertesia antennina</i>	<i>Sertularia cupressina</i>
<i>Grammaria serpens</i>	— <i>ramosa</i>	— <i>tenera</i>
— <i>abietina</i>	<i>Polynemertesia gracillima</i>	— <i>Fabricii</i>
— <i>immersa</i>	* <i>Halicornaria campanulata</i>	— <i>mirabilis</i>
<i>Lictorella pinnata</i>	* <i>Nematocarpus ramuliferus</i>	<i>Hydrallmania falcata</i>
* <i>Zygophylax biarmata</i>	* <i>Aglaophenopsis cornuta</i>	<i>Thujaria thuja</i>
* <i>Stegopoma plicatile</i>	* <i>Cladocarpus integer</i>	— <i>lonchitis</i>
<i>Cuspidella humilis</i>	* — <i>formosus</i>	— <i>laxa</i>
<i>Lafoëina maxima</i>	* — <i>bicuspis</i>	* — <i>alternitheca</i>
<i>Calycella syringa</i>	* <i>Thecocarpus myriophyllum</i>	— <i>arctica</i>
<i>Halecium halecinum</i>	<i>Sertularella tamariscæ</i>	— <i>carica</i>
— <i>Beani</i>	— <i>tricuspidata</i>	<i>Campanularia volubilis</i>
* — <i>scutum</i>	* — <i>amphorifera</i>	<i>Campanularia verticillata</i>
— <i>curvicaule</i>	— <i>polyzonias</i>	— <i>groenlandica</i>
— <i>muricatum</i>	— <i>Gayi</i>	— <i>integra</i>
— <i>labrosum</i>	— <i>rugosa</i>	— <i>Hincksi</i>
— <i>tenuellum</i>	<i>Diphasia fallax</i>	— <i>Johnstoni</i>
— <i>minutum</i>	— <i>Wandeli</i>	<i>Laomedea flexuosa</i>
<i>Kirchenpaueria pinnata</i>	— <i>rosacca</i>	— <i>geniculata</i>
<i>Plumularia setacea</i>	* — <i>attenuata</i>	— <i>longissima</i>
— <i>Catharina</i>	<i>Dynamena pumila</i>	— <i>hyalina</i>
<i>Polyplumaria frutescens</i>	<i>Abietinaria abietina</i>	— <i>gracilis</i>
* — <i>flabellata</i>	— <i>filicula</i>	<i>Bonneviella grandis</i>
* — <i>profunda</i>	— (?) <i>fusca</i>	

An examination of Sæmundsson's material and list (1911) will show that it contains the following synonyms:

<i>Clava squamata</i>	= <i>Clava multicornis</i>
<i>Coryne vermicularis</i>	} = <i>Coryne pusilla</i>
— <i>fruticosa</i>	
<i>Syncoryne eximia</i>	
<i>Syncoryne Sarsii</i>	= <i>Coryne Sarsii</i>
<i>Anliscus pulcher</i>	= <i>Tubularia pulcher</i>
<i>Amalthæa islandica</i>	} = <i>Corymorpha glacialis</i>
<i>Corymorpha glacialis</i>	
<i>Eudendrium rameum</i>	} = <i>Eudendrium rameum</i>
— <i>rigidum?</i>	
<i>Dicoryne conferta</i>	= <i>Bougainvillia conferta</i>
<i>Laomedea gelatinosa</i>	} = <i>Laomedea longissima</i>
— <i>longissima</i>	

<i>Lafoëa pygmaea</i>	}	<i>= Lafœa gracillima</i>
— <i>gracillima</i>		
— <i>pocillum</i>	}	<i>= Lafœa fruticosa</i> forma <i>genuina</i> and forma <i>grandis</i>
— <i>symmetrica</i>		
— <i>fruticosa</i>		
<i>Filellum serpens</i>		<i>= Grammaria serpens</i>
<i>Lictorella Levinsoni</i>		<i>= Zygophylax biarmata</i>
<i>Sertularia cupressina</i>	}	<i>= Sertularia cupressina</i>
— <i>argentea</i>		
— <i>pumila</i>		<i>= Dynamena pumila</i>
<i>Diphasia fusca</i>		<i>= Abictinaria (?) fusca</i>
— <i>abictina</i>		<i>= Abictinaria filicula</i>
<i>Antennularia antennina</i>		<i>= Nemertesia antennina</i>
— <i>ramosa</i>		<i>= — ramosa</i>
<i>Plumularia pinnata</i>		<i>Kirchenpaueria pinnata</i>
— <i>gracillima</i>		<i>= Polynemertesia gracillima</i>
— <i>frutescens</i>		<i>= Polyplumaria frutescens</i>
<i>Thecocarpus radicellatus</i>		<i>= Thecocarpus myriophyllum</i>
<i>Cladocarpus Holmi</i>		<i>= Cladocarpus integer</i>

The synonyms noted reduce the number of species by 9; furthermore, Sæmundsson (1902, 1911) notes *Turris neglecta* Lesson, which here probably represents a young colony of *Clava multicornis*, and *Diplura fritillaria* (Haeckel) = *Coryne fritillaria* Steenstrup, an altogether uncertain species (cf. Part I, p. 23). Renewed investigations must also decide what species is concealed under the name *Perigonimus repens*. Altogether, we have then to reduce the 90 species noted by Sæmundsson to a certain 77. But the geographical details for these species are highly uncertain, as the determination has on revision often proved erroneous. In the revised collections, for instance, we find under the old label "*Thujaria lonchitis*" specimens of *Thujaria lonchitis*, *Thujaria laxa*, *Thujaria alternitheca*, and *Thujaria carica*, while under "*Laomedea flexuosa*" we find labelled, besides specimens actually belonging to that species, also others of *Laomedea geniculata* and *Laomedea longissima*. On the other hand, specimens of *Laomedea longissima* are distributed under the names of *Laomedea flexuosa*, *Laomedea longissima*, and *Laomedea gelatinosa* — taking examples at haphazard. The details are apparent from the notes under the separate headings. Even though the detailed records thus leave much to be desired, we have nevertheless a pretty fair survey of the species comprised under the area as a whole. The investigations have now added the following 14 new species to the list:

<i>Corymorpha groenlandica</i>	<i>Polyplumaria profunda</i>	<i>Cladocarpus bicuspis</i>
<i>Hydractinia Sarsii</i>	<i>Halicornaria campanulata</i>	<i>Sertularella amphory</i>
<i>Stegopoma plicatile</i>	<i>Nematocarpus ramuliferus</i>	<i>Diphasia atto</i>
<i>Halcium scutum</i>	<i>Aglaophenopsis cornuta</i>	<i>Thujaria alternitheca</i>
<i>Polyplumaria flabellata</i>	<i>Cladocarpus formosus</i>	

We have thus reached a total of 91 species certainly known. The nature of the additions is not uninfluenced by the fact that the investigations were largely carried out on the deeper slopes of the coastal banks, so that southern and eurytherm species form the majority of the species thus added to the fauna list of the island.

We now come to the fauna of the Faroe Islands area. The species from here which are included in the material cover the entire range of our present knowledge as to the hydroid fauna of this section. We have here the following 57 species:

<i>Coryne pusilla</i>	<i>Halecium labrosum</i>	<i>Abietinaria abietina</i>
<i>Tubularia indivisa</i>	— <i>tenellum</i>	— <i>filicula</i>
— <i>larynx</i>	<i>Kirchenpaueria pinnata</i>	— (?) <i>fusca</i>
<i>Clava multicornis</i>	<i>Plumularia Catharina</i>	<i>Sertularia cupressina</i>
<i>Merona cornucopiac</i>	<i>Polyplumaria frutescens</i>	— <i>tenera</i>
<i>Bougainvillia conferta</i>	<i>Nemertesia antennina</i>	<i>Hydrallmania falcata</i>
<i>Perigonimus repens</i>	— <i>ramosa</i>	<i>Thujaria thuja</i>
<i>Eudendrium rameum</i>	<i>Nematocarpus ramuliferus</i>	— <i>laxa</i>
— <i>Wrighti</i>	<i>Cladocarpus formosus</i>	<i>Campanularia volubilis</i>
— <i>capillare</i>	<i>Thecocarpus myriophyllum</i>	— <i>verticillata</i>
<i>Lafæa dumosa</i>	<i>Sertularella tamarisca</i>	— <i>integra</i>
— <i>fruticosa</i>	— <i>tricuspidata</i>	— <i>Hincksi</i>
— <i>gracillima</i>	— <i>polyzonias</i>	— <i>Johnstoni</i>
<i>Grammaria serpens</i>	— <i>Gayi</i>	<i>Laomedea flexuosa</i>
— <i>abietina</i>	— <i>tenella</i>	— <i>geniculata</i>
<i>Calycella syringa</i>	— <i>rugosa</i>	— <i>longissima</i>
<i>Halecium halecinum</i>	<i>Diphasia fallax</i>	— <i>hyalina</i>
— <i>scutum</i>	— <i>rosacca</i>	— <i>gracilis</i>
— <i>muricatum</i>	<i>Dynamena pumila</i>	<i>Bonneviella grandis</i>

Along the deepest portions of the slope of the banks, the following five were found: *Tubularia regalis*, *Corymorpha glacialis*, *Corymorpha groenlandica*, *Lictorella pinnata*, and *Sertularella mirabilis*; save for the last but one, all of these belong to the cold area; finds lie so far out in the periphery that it is doubtful whether they should really be counted as belonging to the fauna of the Faroe Bank. If we do so, then we have up to now 62 species recorded from the Faroe Islands section, but the number will doubtless be increased by further study. We must at any rate expect to find the following six species at the Faroe Islands, since they are found, and partly also frequent, in Iceland waters and round the British Isles: *Coryne Sarsii*, *Corymorpha nutans*, *Hydractinia echinata*, *Cuspidella humilis*, *Plumularia setacea*, and *Diphasia attenuata*. This, however probably by no means exhausts the list of species, and in particular we may expect to find more southern forms as more or less sporadic visitors to the Faroe Islands.

A comparison between the fauna of the three areas shows that the Greenland area includes 11 species not known from Iceland or the Faroe Islands. These are:

<i>Coryne Loveni</i>	<i>Perigonimus abyssi</i>	<i>Campanulina turrita</i>
<i>Tubularia regalis</i>	— <i>rosus</i>	<i>Tetrapoma quadridentatum</i>
<i>Branchiocerianthus reniformis</i>	<i>Eudendrium annulatum</i>	<i>Campanularia speciosa</i>
<i>Monobrachium parasitum</i>	<i>Toichopoma obliquum</i>	

Of the species mentioned, however, *Coryne Loveni* is also known from the North Sea as far down as the Danish waters, and it would seem likely that it is identical with the polyp *Coryne fritillaria* Steenstrup, and thus belongs to the Iceland fauna area. *Perigonimus abyssi* and *Perigonimus rosus* extend southward along the west coast of Scandinavia at any rate as far as Bohuslän; *Eudendrium annulatum* has been recorded both in Norwegian and in British waters, and *Campanulina turrita* has been found in Irish waters, near Belfast. In the case of these species it is thus natural to suppose that they will also prove to occur in the intermediate areas at the Faroe Islands and Iceland. The geographical character of *Branchiocerianthus reniformis* is altogether unknown. We have then remaining, as peculiar to Greenland, the species *Tubularia regalis*, *Monobrachium parasitum*, *Toichopoma obliquum*, *Tetrapoma quadridentatum*, and *Campanularia speciosa*, high arctic or panarctic species which appear to be of particularly stenothermic character.

A far more unexpected state of things is met with in the Iceland area. The characteristic species here are:

<i>Tubularia pulcher</i>	<i>Plumularia setacea</i>	<i>Sertularella amphorifera</i>
<i>Corymorpha nutans</i>	<i>Polyplumularia flabellata</i>	<i>Diphasia attenuata</i>
— <i>glacialis</i>	<i>Halicornaria campanulata</i>	<i>Thujaria carica</i>
<i>Zygophylax biarmata</i>	<i>Cladocarpus bicuspis</i>	

Among these there are, as far as our knowledge at present goes, two easterly, panarctic species, to wit, *Corymorpha glacialis* and *Thujaria carica*. These species thus characterise the Icelandic fauna area as the frontier tract for east-arctic species. Similarly, the occurrence of the Greenlandic *Thujaria alternitheca* suggests that the area in question is also a boundary region for westerly, arctic-boreal species. The list given is, however, most striking from the many exotic warm-water species which it contains. The Iceland fauna area has, as a matter of fact, at present several more such species than the Faroe Islands area. It would thus seem as if the influence of the warm atlantic area upon the southern slope of the Iceland grounds is more immediate. How far the Rockall Banks may be partly responsible for the somewhat less marked immigration of warmer atlantic species to the Faroe Islands area cannot be stated with certainty, but there are several indications that such might well be the case.

The Faroe Islands area is distinguished by only two species, *Merona cornucopiae* and *Eudendrium Wrighti*, as against the two other areas; these two species contribute, however, but little to the characterisation of the waters in question as we know them at present. The most striking feature of the true Faroe Bank area is another, negative character, to wit, the lack of high arctic or panarctic species. Only deeper-living arctic species such as *Tubularia regalis*, *Corymorpha glacialis*, *Corymorpha groenlandica*, *Grammaria immersa*, *Stegopoma plicatile*, and *Sertularia Fabricii* verge now

and again on to the deepest parts of the Faroe Bank, where they rise from the cold area at the eastern slopes of the ground.

The community which is characterised by the last-named species, and which further includes *Lafæa fruticosa* forma *grandis*, *Lafæa gracillima* forma *elegantula*, and *Sertularella polyzonias* forma *gigantea*, has its home throughout the whole of the arctic regions; farther to the north, we find it in shallower water, in the southern parts of the cold area in deeper; here also, it penetrates out to the Wyville Thomson ridge in the Faroe Channel, where warm atlantic water-masses present a barrier to its further progress. Only a single find of *Myriothele phrygia* has been made on the southern slope of the Wyville Thomson ridge. These species thus characterise the Norwegian Sea Deep, and show the marked difference between it and the Atlantic deep sea region. The limit of their occurrence here in the south follows on the whole very closely the 0° isotherm.

True these species may at times, in higher latitudes, occur in water layers of higher temperature, but this can have no effect on the limitation of the cold area as a whole against the boreal and atlantic tracts. A biogeographical peculiarity is seen in the Trondhjem Fjord, where hydrographical conditions of an atlantic character prevail, nevertheless we here find *Myriothele phrygia*, *Tubularia regalis*, *Corymorpha groenlandica*, and *Stegopoma plicatile* thriving excellently; indeed, *Tubularia regalis*, and *Stegopoma plicatile* even appear as local character forms in the otherwise purely atlantic *Lophohelia*-biocoenose. This can apparently only be explained by regarding the species as relicts in the fjord, which have been able to adapt themselves to altered conditions there. This exception, however, cannot alter their general character as arctic species.

On the other hand, we find in the material also species which are not able to penetrate beyond the limits of the warm atlantic water-layers, and which are thus entirely lacking in the boreal region. These species emphasise still further the marked difference between the fauna of the Atlantic abyssal region and the cold area. We may here in particular point out *Grammaria conferta*, *Zygophylax biarmata*, *Polyplumaria profunda*, and *Sertularella amphorifera*, typical representatives of the warm atlantic deep-sea fauna. The finding of these so far to the north shows us on the one hand how uniform the fauna must be throughout the deep region of the Atlantic, but also, on the other hand, how little we yet know as to the geographical distribution of the bottom fauna, and what great and tempting tasks still await the investigator in thoroughly elucidating the question of bottom fauna even here in the North Atlantic.

V. List of the genera treated, and type-species.

(Nomina conservanda).

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|--------------------------------------|---|
| <i>Coryne</i> , Gaertner | <i>Coryne pusilla</i> , Gaertner 1774. |
| <i>Myriothecla</i> , M. Sars | <i>Lucernaria phrygia</i> , Fabricius 1780. |
| <i>Tubularia</i> , Linné | <i>Tubularia indivisa</i> , Linné 1758. |
| <i>Corymorpha</i> , M. Sars | <i>Corymorpha nutans</i> , M. Sars 1835. |
| <i>Branchiocerianthus</i> , Mark | <i>Monocaulus imperator</i> , Allman 1888. |
| <i>Clava</i> , Gmelin | <i>Hydra multicornis</i> , Forskål 1775. |
| <i>Merona</i> , Norman. | <i>Tubiclava cornucopiae</i> , Norman 1864. |
| <i>Monobrachium</i> , Mereschkowsky. | <i>Monobrachium parasitum</i> , Mereschkowsky 1877. |
| <i>Hydractinia</i> , van Beneden. | <i>Alcyonium echinatum</i> , Fleming 1828. |
| <i>Bougainvillia</i> , Lesson. | <i>Eudendrium ramosum</i> , van Beneden 1844. |
| <i>Perigonimus</i> , M. Sars. | <i>Perigonimus muscoides</i> , M. Sars 1846. |
| <i>Eudendrium</i> , Ehrenberg. | <i>Tubularia ramosa</i> , Linné 1758. |
| <i>Lafœa</i> , Lamouroux. | <i>Campanularia dumosa</i> , Fleming 1820. |
| <i>Toichopoma</i> , Levinsen. | <i>Calycella obliqua</i> , Hincks 1874. |
| <i>Grammaria</i> , Stimpson. | <i>Campanularia abietina</i> , M. Sars 1851. |
| <i>Lictorella</i> , Allman. | <i>Lafoëa pinnata</i> , G. O. Sars 1874. |
| <i>Zygophylax</i> , Quelch. | <i>Zygophylax profunda</i> , Quelch 1885. |
| <i>Stegopoma</i> , Levinsen. | <i>Calycella plicatilis</i> , G. O. Sars 1874. |
| <i>Cuspidella</i> , Hincks. | <i>Campanularia humilis</i> , Alder 1863. |
| <i>Lafoëina</i> , M. Sars. | <i>Lafoëina tenuis</i> , M. Sars 1869. |
| <i>Campanulina</i> , van Beneden. | <i>Campanulina tenuis</i> , van Beneden 1847. |
| <i>Calycella</i> , Hincks. | <i>Sertularia syringa</i> , Linné 1767. |
| <i>Tetrapoma</i> , Levinsen. | <i>Calycella quadridentata</i> , Hincks 1874. |
| <i>Halecium</i> , Oken. | <i>Sertularia halccina</i> , Linné 1758. |
| <i>Kirchenpaueria</i> , Jickeli. | <i>Sertularia pinnata</i> , Linné 1758. |
| <i>Plumularia</i> , Lamarck. | <i>Sertularia setacea</i> , Linné 1758. |
| <i>Polyplumaria</i> , G. O. Sars. | <i>Polyplumaria flabellata</i> , G. O. Sars 1874. |
| <i>Nemertesia</i> , Lamouroux. | <i>Sertularia antennina</i> , Linné 1758. |
| <i>Polynemertesia</i> , nov. | <i>Plumularia gracillima</i> , G. O. Sars 1873. |
| <i>Halicornaria</i> (Busk). | <i>Halicornaria bipinnata</i> , Allman 1876. |
| <i>Nematocarpus</i> , nov. | <i>Halicornaria ramulifera</i> , Allmann 1874. |
| <i>Aglaophenopsis</i> , Fewkes. | <i>Aglaophenopsis hirsuta</i> , Fewkes 1881. |
| <i>Cladocarpus</i> , Allman. | <i>Cladocarpus formosus</i> , Allman 1874. |
| <i>Thecocarpus</i> , Nutting. | <i>Sertularia myriophyllum</i> , Linné 1758. |
| <i>Aglaophenia</i> , Lamouroux. | <i>Sertularia pluma</i> , Linné 1758. |
| <i>Sertularella</i> , Gray. | <i>Sertularia polyzonias</i> , Linné 1758. |

<i>Diphasia</i> , L. Agassiz.	<i>Sertularia rosacea</i> , Linné 1758.
<i>Dynamena</i> , Lamouroux.	<i>Sertularia pumila</i> , Linné 1758.
<i>Abictinaria</i> , Kirchenpauer.	<i>Sertularia abietina</i> , Linné 1758.
<i>Sertularia</i> , Linné.	<i>Sertularia cupressina</i> , Linné 1758.
<i>Hydrallmania</i> , Hincks.	<i>Sertularia falcata</i> , Linné 1758.
<i>Thujaria</i> , Fleming.	<i>Sertularia thuja</i> , Linné 1758.
<i>Campanularia</i> , Lamarck.	<i>Sertularia volubilis</i> , Linné 1758.
<i>Laomedea</i> , Lamouroux.	<i>Laomedea flexuosa</i> , Alder 1856.
<i>Bonneviella</i> , Broch.	<i>Campanularia grandis</i> , Allman 1874.

Trondhjem, 24.—VI.—1917.

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- *(?) tubuliformis* II 132, 182
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- *distans* II 149
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— <i>kolaënsis</i>	II 146	— <i>cornucopia</i>	I 2
— <i>laxa</i>	II 140, 142, 147, 188, 190, 191, 192	— <i>coronata</i>	I 2
— <i>lonchitis</i>	II 142, 143, 144, 145, 146, 190, 191	— <i>humilis</i>	I 2
— <i>pectinata</i>	II 146	— <i>indivisa</i>	I 6, 8, 24, 26, 30, 55, II 187, 189, 192, 195
— <i>plumosa</i>	II 122	— <i>larynx</i>	I 8, 27, II 189, 192
— <i>robusta</i>	II 122	— <i>obliqua</i>	I 21
— <i>salicornia</i>	II 120	— <i>prolifer</i>	I 2
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<i>Tubiclava cornucopiae</i>	I 40, II 195	— <i>profunda</i>	II 195

ERRATA.

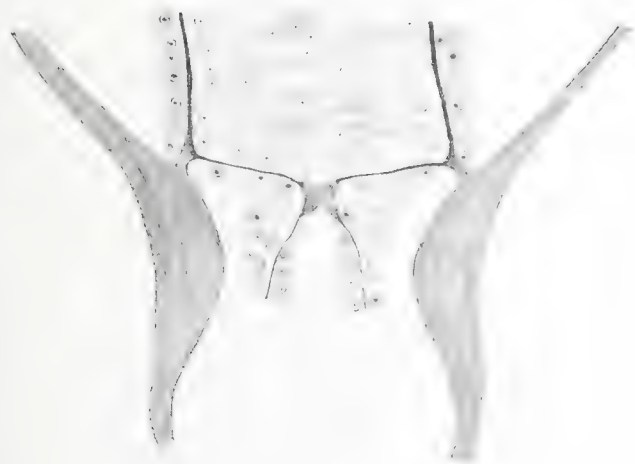
Part I pag. 6, line 10 stands: *heteromedusoid*, read: *cryptomedusoid*.

Part II pag. 2 and following: *Lafoëidae*, *Lafoëa*, read: *Lafæidae*, *Lafæa*.

Part II pag. 99, text, line 2 stands: From there is penetrates, read: From there it penetrates.

Plate I.

- Fig. 1. *Campanularia integra*. Part of median longitudinal section showing basal part of hydranth and inner thickening of hydrotheca wall, to the upper side of which the hydranth is attached. No trace of diaphragm whatever. Specimen from Herlö, near Bergen, fixed in picrin-sublimate-acetic acid (after Rabl), coloured with Delafield's hæmatoxyline — van Giesson. 320/1.
- Fig. 2. *Branchiocerianthus reniformis*. Type specimen from "Ingolf" St. 28. Nat. size.
- Fig. 3. *Branchiocerianthus reniformis*. Hydranth seen from below. 2/1.
- Fig. 4. *Branchiocerianthus reniformis*. Hydranth seen from above. The richly folded gastral endoderm distinctly visible through the large oral aperture. 2/1.
- Fig. 5. *Branchiocerianthus reniformis*. Primary branch of a blastostyle, showing method of ramification. The outer, grape-like swellings are close collections of quite small incipient gonophores. 30/1



THE INGOLF-EXPEDITION

1895-1896.

THE LOCALITIES, DEPTHS, AND BOTTOMTEMPERATURES OF THE STATIONS

Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom- temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom- temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom- temp.
1	62° 30'	8° 21'	132	7.2	24	63° 06'	56° 00'	1199	2.4	25	63° 32'	9° 43'	613	7.2
2	63° 04'	9° 22'	292	5.3	25	63° 30'	54° 25'	582	3.3	26	63° 32'	11° 36'	720	7.2
3	63° 35'	10° 24'	272	0.3		63° 51'	53° 03'	136		27	63° 32'	13° 40'	950	7.2
4	64° 07'	11° 12'	237	2.5	29	63° 57'	52° 41'	34	0.6	28	63° 32'	15° 11'	1150	7.2
5	64° 40'	12° 09'	155			64° 37'	54° 24'	109		29	63° 07'	15° 07'	1120	7.2
6	63° 43'	14° 34'	99	7.0	27	64° 54'	55° 10'	393	5.8	30	63° 43'	15° 07'	1020	7.2
7	63° 13'	15° 11'	600	1.5	28	65° 14'	55° 42'	420	2.5	31	64° 15'	14° 22'	68	7.2
8	63° 56'	24° 40'	136	0.0	29	65° 34'	54° 31'	68	0.2	32	64° 57'	13° 32'	420	7.2
9	64° 18'	27° 00'	295	5.8	30	66° 50'	54° 28'	22	1.05	33	64° 15'	15° 07'	795	7.2
10	64° 24'	28° 50'	788	3.5	31	66° 35'	55° 54'	88	1.6	34	63° 08'	15° 40'	691	7.2
11	64° 34'	31° 12'	1300	1.6	32	66° 35'	56° 38'	318	1.6	35	63° 33'	15° 02'	316	7.2
12	64° 38'	32° 37'	1040	0.3	33	67° 57'	55° 30'	35	0.8	36	64° 00'	15° 09'	68	7.2
13	64° 47'	34° 33'	622	3.0	34	68° 17'	54° 17'	55		37	64° 37'	13° 02'	350	7.2
14	64° 45'	35° 05'	176	1.1	35	68° 16'	55° 05'	362	3.6	38	64° 25'	12° 09'	211	7.2
15	66° 18'	25° 59'	330	0.75	36	61° 50'	56° 21'	1435	1.5	39	64° 00'	11° 16'	310	7.2
16	65° 43'	26° 58'	250	0.1	37	60° 17'	54° 05'	1715	1.1	40	64° 09'	12° 27'	124	7.2
17	62° 49'	26° 55'	745	3.4	38	59° 13'	51° 05'	1870	1.3	41	64° 03'	13° 06'	55	7.2
18	61° 44'	30° 29'	1135	3.0	39	62° 00'	22° 38'	865	2.9	42	64° 18'	19° 12'	72	7.2
19	60° 29'	34° 14'	1566	2.4	40	62° 00'	21° 36'	845	3.3	43	64° 40'	19° 05'	800	7.2
20	58° 20'	40° 48'	1695	1.5	41	61° 39'	17° 10'	1245	2.6	44	64° 06'	19° 00'	1041	7.2
21	58° 01'	44° 15'	1330	2.4	42	61° 11'	10° 17'	625	1.4	45	64° 33'	19° 00'	1089	7.2
22	58° 10'	48° 25'	1845	1.1	43	61° 12'	10° 11'	645	1.5	46	64° 33'	20° 43'	1128	7.2
23	60° 43'	56° 00'	Only the Plankton-Net used		44	61° 12'	9° 36'	545	1.7	47	64° 30'	22° 30'	975	7.2

Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom- temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom- temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom- temp.
68	62° 06'	22° 30'	843	3° 4	92	64° 44'	32° 52'	976	1° 4	118	68° 27'	8° 20'	1060	-1° 0
69	62° 40'	22° 17'	589	3° 9	93	64° 24'	35° 14'	767	1° 46	119	67° 53'	10° 19'	1010	-1° 0
70	63° 09'	22° 05'	134	7° 0	94	64° 56'	36° 19'	204	4° 1	120	67° 29'	11° 32'	885	-1° 0
71	63° 46'	22° 03'	46			65° 31'	30° 45'	213		121	66° 59'	13° 11'	529	-0° 7
72	63° 12'	23° 04'	197	6° 7	95	65° 14'	30° 39'	752	2° 1	122	66° 42'	14° 44'	115	1° 8
73	62° 58'	23° 28'	486	5° 5	96	65° 24'	29° 00'	735	1° 2	123	66° 52'	15° 40'	145	2° 0
74	62° 17'	24° 36'	695	4° 2	97	65° 28'	27° 39'	450	5° 5	124	67° 40'	15° 40'	495	-0° 6
	61° 57'	25° 35'	761		98	65° 38'	26° 27'	138	5° 9	125	68° 08'	16° 02'	729	-0° 8
	61° 28'	25° 06'	829		99	66° 13'	25° 53'	187	6° 1	126	67° 19'	15° 52'	293	-0° 5
75	61° 28'	26° 25'	780	4° 3	100	66° 23'	14° 02'	59	0° 4	127	66° 33'	20° 05'	44	5° 6
76	60° 50'	26° 50'	806	4° 1	101	66° 23'	12° 05'	537	-0° 7	128	66° 50'	20° 02'	194	0° 6
77	60° 10'	26° 59'	951	3° 6	102	66° 23'	10° 26'	750	-0° 9	129	66° 35'	23° 47'	117	6° 5
78	60° 37'	27° 52'	799	4° 5	103	66° 23'	8° 52'	579	-0° 6	130	63° 00'	20° 40'	338	6° 55
79	60° 52'	28° 58'	653	4° 4	104	66° 23'	7° 25'	957	-1° 1	131	63° 00'	19° 09'	698	4° 7
80	61° 02'	29° 32'	935	4° 0	105	65° 34'	7° 31'	762	-0° 8	132	63° 00'	17° 04'	747	4° 6
81	61° 44'	27° 00'	485	6° 1	106	65° 34'	8° 54'	447	-0° 6	133	63° 14'	11° 24'	230	2° 2
82	61° 55'	27° 28'	824	4° 1		65° 29'	8° 40'	466		134	62° 34'	10° 26'	299	4° 1
83	62° 25'	28° 30'	912	3° 5	107	65° 33'	10° 28'	492	-0° 3	135	62° 48'	9° 48'	270	0° 4
	62° 36'	26° 01'	472		108	65° 30'	12° 00'	97	1° 1	136	63° 01'	9° 11'	256	4° 8
	62° 36'	25° 30'	401		109	65° 29'	13° 25'	38	1° 5	137	63° 14'	8° 31'	297	-0° 6
84	62° 58'	25° 24'	633	4° 8	110	66° 44'	11° 33'	781	-0° 8	138	63° 26'	7° 56'	471	-0° 6
85	63° 21'	25° 21'	170		111	67° 14'	8° 48'	860	-0° 9	139	63° 36'	7° 30'	702	-0° 6
86	65° 03' 6	23° 47' 6	76		112	67° 57'	6° 44'	1267	-1° 1	140	63° 29'	6° 57'	780	-0° 9
87	65° 02' 3	23° 56' 2	110		113	69° 31'	7° 06'	1309	-1° 0	141	63° 22'	6° 58'	679	-0° 6
88	64° 58'	24° 25'	76	6° 9	114	70° 36'	7° 29'	773	-1° 0	142	63° 07'	7° 05'	587	-0° 6
89	64° 45'	27° 20'	310	8° 4	115	70° 50'	8° 29'	86	0° 1	143	62° 58'	7° 09'	388	-0° 4
90	64° 45'	29° 06'	568	4° 4	116	70° 05'	8° 26'	371	-0° 4	144	62° 49'	7° 12'	276	1° 6
91	64° 44'	31° 00'	1236	3° 1	117	69° 13'	8° 23'	1003	-1° 0					



THE DANISH INGOLF-EXPEDITION.

VOLUME V.

8.

MEDUSÆ.

PART I.

LEPTOMEDUSÆ.

BY

P. L. KRAMP.

WITH 5 PLATES, 17 FIGURES IN THE TEXT, AND 14 MAPS

1965-44

11:6:25

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Introduction.

In the present paper as also in one or two more to be published later on, the Medusæ from the northern Atlantic and adjacent waters will be dealt with. Owing to various casual circumstances the group of the Leptomedusæ has been worked up as the first. The geographical area, dealt with in the said works, comprises: the Atlantic Ocean north of Lat. 50° N., the Davis Strait, the western part of the North Sea, the Norwegian Sea, and the Polar Sea as far eastwards as the Kara Sea. The choice of the southern limit is rather gratuitous. The medusæ from the British Channel are going to be mentioned in the "Report on the Danish Oceanographical Expeditions 1908—1909 to the Mediterranean and adjacent Waters", dealing with the fauna of the Mediterranean and the Atlantic from the coast of Morocco to the British Channel. Moreover I am preparing a work on the medusæ of the Danish waters; in the present paper, therefore, I have only included some few summary remarks on the medusæ from that area.

The present paper is based particularly on the collections in the Zoological Museum of the University of Copenhagen. Besides I have made use of a smaller collection of medusæ belonging to the Plankton Department of the Danish Commission for Investigation of the Sea. For the admission to that collection I owe my best thanks to Professor C. H. Ostenfeld, the Director of the Plankton Laboratory. Moreover, during a stay in Bergen in the summer of 1916 I studied the exceedingly interesting material of medusæ collected during the first cruise of the M.S. "Armauer Hansen" in the Atlantic west of Rockall in 1913; some of the specimens were sent to me to Copenhagen for further investigation. With the permission of Professor A. Brinkmann the results of my studies have been included in the present paper. I wish to express my best thanks to Professor Brinkmann for that permission.

Some years ago I was commissioned to work up the Anthomedusæ and Leptomedusæ from the "Michael Sars" North Atlantic Deep-Sea Expedition 1910. The paper was finished in 1915, and the printing was nearly accomplished, when the great fire in Bergen on January 15th 1916 destroyed the matter in type; the printing has not yet been resumed, and as certain parts of the material dealt with in that paper are of considerable interest with regard to the problems discussed in the present work, I have made use of that material to such an extent as I found suitable.

Some of the material in the Zoological Museum of Copenhagen has previously been worked up and mentioned in the literature. Some older material has been examined by E. Haeckel and mentioned in his *System der Medusen*. The museum possesses a list of that material, to which Haeckel himself has added the identifications of the species. The numbers in the list are re-found in the labels of the specimens. The said list is of considerable interest, as far as it has rendered it possible to correct some of Haeckel's identifications. The medusæ from Greenland were dealt with by G. M. R. Levinsen in "*Meduser, Ctenophorer og Hydroider fra Grønlands Vestkyst*" 1892, and, later, by the present author in "*Medusæ collected by the "Tjalfe" Expedition*" (1913), and "*Meduser og Siphonophorer*" in *Conspectus Faunæ Groenlandicæ* (1914). The last-mentioned paper includes a complete account of the literature relating to the medusæ of the waters of Greenland.

Besides the older material, the collections of the following expeditions have been employed in the present paper:

Wm. Lundbeck, 1892 (Iceland).

Danish "Ingolf" Expedition, 1895 and 1896 (Faeroe Islands, Iceland, and Greenland).

Inspecting-ship "Diana", A. Ditlevsen, 1902 (Iceland).

"Michael Sars", Ad. S. Jensen, 1902 (Norway and Iceland).

"Michael Sars", 1903 (Norwegian Sea).

Inspecting-ship "Beskytteren", C. V. Otterstrøm 1903, K. J. Gemzøe 1904, and F. Johansen 1905 (Iceland).

"Thor", fisheries-investigations 1903, 1904, 1905, 1906, and 1908 (British Isles, Norway, Faeroe Islands, Iceland).

"Tjalfe", 1908 and 1909 (West-Greenland).

"Armauer-Hansen", Norwegian research motorship, 1913 (West of Rockall).

The state of preservation of the material has partly been very satisfactory (formalin), particularly as far as the collections of the "Thor" and the "Tjalfe" are concerned. The material of the "Diana" is likewise generally well preserved, though it has only been treated with alcohol; the same testimony is partly applicable to the material from the "Beskytteren" collected by Gemzøe. The material from the "Ingolf" Expedition, on the other hand, is as a rule very badly preserved. Especially a great lot of specimens have been spoiled owing to the usage of osmic acid or Flemmings solution. As a matter of fact, these substances have quite a ruinous effect on medusæ, particularly so if the dissolution is too concentrated and the specimens are exposed to the influence of the fluid during a too long space of time. Not merely the pigmentation is concealed, but the animals become intransparent and very much fragile, and must be handled with the utmost care not to break during the examination. Indeed, still during the transportation in the glasses a great part of the material has been shaken into small fragments. Neither are the single organs better hardened for investigation by this method of preparation; I have tried sectioning on microtome different organs of specimens treated with Flemmings solution, and the tissues are by no means better preserved, rather more badly if anything, than in the case of animals merely preserved in common alcohol or formalin. The method of treating medusæ with fluids containing osmic acid seems to have been very favourite during a certain period; on account

of sad experiences, I take this opportunity to warn against the use of these substances for preparation of medusæ.

In the case of such species, of which no modern descriptions have been given, I have carried out thorough examinations of the morphology, as far as the state of preservation has rendered such examination possible. Also in the case of well-known species I have in some cases discovered interesting structures, hitherto unobserved. It is really astonishing, how most medusæ are deficiently known with regard to their morphology. It is a well-known fact, that the classification of the Leptomedusæ is extremely difficult. I am quite aware, that a correct understanding of the systematical problems must be searched for not only through hatching experiments, by means of which we get knowledge of the connection between the hydroids and the medusæ, but also through thorough comparative-morphological investigations. As a matter of course, I cannot, in the present paper, enter into a discussion of the great and complicated systematical problems; my present knowledge of other forms of medusæ than the northern species is too deficient yet for such an undertaking. But it is my hope, that my investigations, when in course of time they are followed by others, may contribute to that understanding which, we may hope, must be reached once in the future.

In some cases I have discussed the history of a species or genus in order to remove existing confusion or to state the correct name of the species or genus in question.

The number of species of Leptomedusæ, identified with certainty, and occurring in the north-atlantic area here dealt with, amounts to a little more than 25. In the material examined by me 15 species are represented, excluding the non-identified species of *Obelia*. They belong to the families *Laodiceidæ*, *Thaumantiadæ*, *Mitrocomidæ* and *Eucopidæ*. The family of the *Æquoridæ* is not represented. In order to give a picture, as complete as possible, of the north-atlantic fauna of medusæ, I have included the species of which no material has been at my disposal, but which, according to the literature, occur within the area in question. For such species, I give a short diagnosis, mainly derived from A. G. Mayer, *Medusæ of the World*, 1910, together with summary remarks on their distribution.

The following 15 species have been examined:

<i>Chromatonema rubrum</i> Fewkes	<i>Halopsis ocellata</i> A. Agassiz
<i>Laodicea undulata</i> (Forbes & Goodsir)	<i>Tiaropsis multicirrata</i> (M. Sars)
<i>Ptychogena lactea</i> A. Agassiz	<i>Obelia nigra</i> Browne
<i>Staurophora mertensii</i> Brandt	<i>Phialidium hemisphæricum</i> (Gronovius)
<i>Melicertum octocostatum</i> (M. Sars)	— <i>islandicum</i> nov. spec.
<i>Mitrocoma polydiademata</i> (Romanes)	<i>Eutonina indicans</i> (Romanes)
<i>Cosmetira pilosella</i> Forbes	<i>Tima bairdii</i> (Johnston)
— <i>megalota</i> (Maas)	

Moreover the following species have been included (printed with Petit):

<i>Dipleurosoma typicum</i> Boeck	<i>Eucheilota maculata</i> Hartlaub
<i>Agastra mira</i> Hartlaub	<i>Saphenia gracilis</i> (Forbes & Goodsir)
<i>Eucope globosa</i> (Forbes)	<i>Eutima insignis</i> (Keferstein)

Eutima elephas (Haeckel)

Æquorea forskålea Péron & Lesueur

Octorchis gegenbauri (Haeckel)

Zygodactyla groenlandica (Péron & Lesueur)

Eirene viridula (Péron & Lesueur)

Family Laodiceidæ Browne.

"Leptomedusæ with cordyli, commonly called sensory clubs, on the margin of the umbrella"
(Browne 1907, p. 459).

Browne has, no doubt correctly, ascribed the significance as a family-character to the peculiar organs called cordyli. Before I enter into a further discussion of these interesting organs, I will, for the sake of comparison, shortly call attention to the structure of another kind of marginal appendages, occurring in several Leptomedusæ: *viz.* the Cirri. A cirrus is lengthened, thread-shaped, and is always inserted directly on the margin of the umbrella without possessing a basal bulb. The entoderm of the cirrus is in connection with the entoderm of the circular vessel, and it is solid (not hollow), consisting of a single series of cylindrical or disk-shaped entoderm-cells. The ectodermal epithelial cover is very delicate, consisting of flattened polygonal cells. The cirri carry nematocysts, usually in considerable number, and particularly towards the distal end. The distal part of the cirrus may, as a rule, be spirally curled up.

A typical, fully developed Cordylus is club-shaped with a thin stalk and a swollen distal part; it may or may not be mounted upon a small tubercle on the bell margin. In opposition to the cirrus, it possesses a hollow central space which, however, may be more or less obliterated; particularly the lumen has often entirely disappeared in the narrow part, the lumen of the distal thick part thus being separated from that of the circular vessel. The entoderm consists of a single layer of large, usually cubical cells surrounding the central lumen. The ectoderm is fairly thin, but not so thin as the ectoderm of a cirrus. There are no nematocysts. This is the shape of a typical cordylus. A very interesting kind of cordylus, not so highly developed, has been observed by Browne in *Ptychogena antarctica* Browne (Browne 1910). The cordyli of that species, as figured by Browne (Plate 2, figs. 7—9) do not possess the well-marked club-shaped appearance as in the case of the typical cordyli, but are only slightly more thickened distally than proximally; moreover, in some of them nematocysts were found.

I am of opinion, that the small marginal appendages in *Chromatonema rubrum* indicate a still lower stage of development of cordyli (see Plate I, figs. 2 and 3). They differ from typical cordyli by the possession of a cluster of nematocysts in the distal end and by the general shape which is cylindrical or spindle-shaped. But the ground plane, the structure of the cell-layers, is exactly as in a cordylus. Through the cordyli of *Ptychogena antarctica*, mentioned above, as the transitional form they may, I think, without difficulty be homologized with real cordyli. They may not be called cirri, as they have a central lumen, and because they are short and rigid. In a nearly related species, *Chromatonema erythronon* (*Ptychogena erythronon* Bigelow), further mentioned below, Bigelow found a few cylindrical "cirri" with nematocysts and, besides, a number of spindle-shaped "cordyli" without nematocysts. Excepting the lacking of nematocysts, these cordyli have exactly the same shape as those of *Chromatonema rubrum*, and they occupy a corresponding position on the bell margin.

Thus they must undoubtedly be characterised as another transitional form, somewhat further advanced than the corresponding organs in *Chromatonema rubrum*. — In another nearly related species, *Chromatonema hertwigi* (*Ptychogena hertwigi* Vanhöffen, see below) the same organs are, according to the figure, partly cylindrical, partly spindle-shaped, partly somewhat club-shaped; Vanhöffen calls them "cirri".

Thus we find, within the *Laodiceidæ*, a series of transitional forms of cordyli from cylindrical or spindle-shaped with a distal cluster of nematocysts (*Chromatonema rubrum*) through spindle-shaped or slightly club-shaped with or without nematocysts, to the fully developed form: actually club-shaped without nematocysts.

As different points of connection exist between the *Laodiceidæ* and the *Tiaridæ*, as will presently be demonstrated, it is a natural question, whether anything corresponding to cordyli is found among the latter. We will find then, that a single form of *Tiaridæ* possesses certain organs, which bear a considerable likeness to the lowest form of cordyli, those of *Chromatonema rubrum*. The species in question is *Tiaranna rotunda* (Quoy & Gaimard).

I deeply regret that my paper on the Anthomedusæ and Leptomedusæ of the "Michael Sars" Expedition 1910 has not yet been printed, as two species of the interesting genus *Tiaranna* have been dealt with in that paper; a reference to the accounts of these species would have facilitated the following discussion on the relation between the *Tiaridæ* and the *Laodiceidæ*. As especially *Tiaranna rotunda* is of great interest in this respect, I have thought it better to make use, in this place, of my observations relating to the matter in spite of the fact, that they are destined for printing in another place.

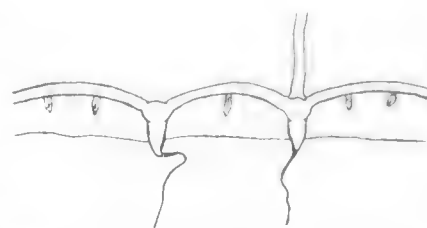


Fig. 1. Part of the bell-margin of *Tiaranna rotunda* (Quoy & Gaimard).

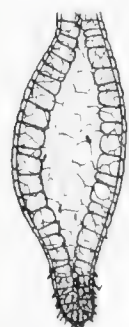


Fig. 2. Dwarf-tentacle of *Tiaranna rotunda* (Quoy & Gaimard), with numerous nematocysts at the distal end.

The marginal appendages of *Tiaranna rotunda* (textfig. 1) are very much like those of *Chromatonema rubrum*. Between every successive pair of tentacles in *Tiaranna rotunda* there are one or two minute appendages like the cordyli of *Chromatonema*, only they are never cylindrical, but always spindle-shaped, and provided with a tenon-like distal part greatly armoured with nematocysts (textfig. 2). The structure of the cell-layers is exactly as in the cordyli of *Chromatonema*. Dwarf-tentacles of a similar shape, though more lengthened, are found in *Bythotiara*.

Hartlaub (1897) considered cordyli to be juvenile stages of tentacles, and he meant to have observed the development of cordyli into tentacles in *Staurophora mertensii*. Browne has discussed this question in his paper, Revision of the ... *Laodiceidæ* (1907, p. 458). Browne has examined a large number of specimens of *Laodicea undulata* (early and intermediate stages). He is of opinion, that transformation of cordyli into tentacles does not take place normally, though such transformation may happen when the margin of the bell is overcrowded with marginal organs; in such case a cordylus may stand in the way of a developing tentacle and may, thereby, be lifted up by the growing bulb and become situated on the distal end of the young tentacle; afterwards it gradually loses its rounded form and is finally absorbed. Browne rightly remarks: "If cordyli are the forerunners of tentacles one would naturally expect to see them in the earliest stage or in the very early stages; but they do not make their appearance

until the Medusa has at least trebled the original number of its tentacles". Only in very few cases Browne found cordyli being converted into tentacles; on the other hand, I have observed several cases of the same phenomenon in *Staurophora mertensii*. Plate III fig. 7 illustrates different stages of cordyli being converted into tentacles in a specimen from Iceland. Fig. 7 a shows a normal cordylus without basal bulb; in fig. b is seen a normal cordylus mounted upon a young bulb; figs. c—f illustrate some stages of the further development into a young tentacle, the distal part of which is still distinctly club-shaped; in stages, still further advanced, I have seen the bulbous terminal part in a state of absorption. On the other hand, I have also seen numerous young tentacles with an entirely pointed terminal part, tentacles which have, accordingly, never had any connection with cordyli. As a result of my investigations I may state, I believe, that Browne's view of this question is correct, though in species in which the marginal organs are very densely crowded, it will very frequently happen, that cordyli are picked up by developing tentacles.

According to Browne, the family *Laodiceidæ* comprises the following genera: *Laodicea*, *Staurophora*, *Ptychogena*, *Toxorhis*, *Staurodiscus*, and *Melicerissa*. To these we may add, I believe, the genus *Chromatonema*. Among the genera mentioned by Browne, I know only the three first by autopsy; the three others I have never seen. I will, therefore, not enter into a general account of the comparative morphology of the family. But from my studies on the species, represented in the material at my disposal, I shall call attention to certain parallels to structures within the family *Tiaridæ*, parallels which, after my opinion, render it probable, that the *Laodiceidæ* have taken their origin from that group.

One feature, common for the *Laodiceidæ* (the species examined by me) and the proper *Tiaridæ* (the *Neoturridæ* sensu Hartlaub) is the wide, open mouth tube, the free margin of which is more or less crenulated (except in the lower forms among the *Tiaridæ*), often complexly folded. The perradial corners of the mouth is, in most forms, more or less drawn out into four lips. Another common feature is the fact, that the manubrium is attached to the subumbrella along the arms of a perradial cross.

In the *Tiaridæ* the gonads are developed into folds or grooves in the walls of the stomach. Typically these grooves are arranged in the shape of four horse-shoes, the middle curves of which are placed interradially on the upper (proximal) part of the manubrium, while the arms go downwards along both sides of the perradial edges of the stomach. From this type the arrangement may be further developed in a more or less complicated manner. In some of the *Calycopsidæ* the horse-shoe-shape has been obliterated, because no sexual products are developed in the interradiial parts, the gonads thus being arranged as eight adradial rows of sacks.

A characteristic structure in many *Tiaridæ* are the so-called "mesenteries", a double membrane connecting a greater or lesser part of the perradial edges of the stomach with the radial canals. These mesenteries are very differently developed in the different forms of *Tiaridæ*. In the lower forms they are quite absent; they are well-developed in such higher organized forms as *Leuckartiara*, *Catablema*, *Neoturris*, *Pandea* etc. If we imagine the mesenteries so far lengthened, that they reach as far downwards along the edges of the stomach as the gonads and, at the same time, just as far outwards along the radial canals, and if we fancy, thereafter, that they become narrowed in a dorso-ventral direction, the edges of the stomach will be drawn outwards towards the radial canals and, at last, coincide with the latter. That is, in fact, what we find in *Tiaranna rotunda* and *affinis* (figures of these

species are given in my paper on the Anthomedusæ and Leptomedusæ of the "Michael Sars"). Now it is not difficult to fancy a transition from the facts as established in these species to the type of gastrogenital organs found in most *Laodiceide*. If the gonads disappear in the interradial parts, we have, on each side of the radial canals so far as these are connected with the edges of the stomach, a series of gonadial folds, forming together a continuous, folded band along the part of the canal concerned. An outward displacing (towards the bell-margin) of these gonads will have the effect, that the proximal ends are somewhat withdrawn from the centre of the umbrella, while the distal ends, being removed outwards, will drag along with them the adjacent parts of the wall of the stomach, forming a funnel-shaped extension of the stomach along the lower side of each of the radial canals. Then we have the type, which is found in *Ptychogena* and *Laodicea* (see below). The modification of this type within the different forms, here dealt with, will be mentioned below under the descriptions of the species.

The emancipation of the gonads from the stomach is not so far advanced in the *Laodiceide* (the species here described) as in the other Leptomedusæ; this indicates a lower systematical position nearer to the Anthomedusæ. In *Laodicea*, *Ptychogena* and *Staurophora* the gonads are developed in folds of the lateral walls of the radial canals; in the case of the two first mentioned genera the proximal parts of the gonads are frequently developed in the walls of the stomach along both sides of the lines (the cross-shaped figure) by which the stomach is attached to the subumbrella. In *Staurophora* the structure of the gastrogenital organs is secondarily complicated (see below). In *Chromatonema* the gonads do not form continuous bands, but consist of a row of sack-shaped invaginations on each side of the radial canals; some of the proximal gonadial sacks are situated within the corners of the stomach in the dorsal walls of the latter along the arms of the cross-shaped figure. These gonadial sacks, with their narrow, split-shaped openings, recall the gonadial sacks, arranged in rows, in *Calyropsis*.

Genus *Chromatonema* Fewkes.

Chromatonema rubrum Fewkes.

Plate I, figs. 1—8.

Chromatonema rubrum Fewkes 1882. Acalephæ, East Coast of New England. — Bull. Mus. Comp. Zool. Vol. 9. No. 8, p. 305. Pl. I, fig. 41.

Thaumantias — Mayer 1910. Medusæ of the World. Vol. I, p. 199.

— — Kramp 1913. Medusæ, "Tjalfe"-Exp. — Vidensk. Meddel. Dansk naturh. Foren. Bd. 65, p. 267.

— — Kramp 1914. Meduser og Siphonophorer. — Conspectus Faunæ Groenlandicæ, p. 419.

?*Ptychogena erythrogonon* Bigelow 1909. Medusæ, Eastern Tropical Pacific. — Mem. Mus. Comp. Zool. Vol. 37, p. 150. Pl. 5, fig. 1. Pl. 38, figs. 8, 9. Pl. 39, figs. 1—7.

? — *Hertwigi* Vanhöffen 1911. Deutsche Tiefsee-Exped. Bd. 19, p. 220. Taf. 22, Fig. 9. Textfig. 13.

Description. — The bell is somewhat higher than a hemisphere, the gelatinous substance very thick, evenly rounded at the top, gradually tapering towards the bell margin. The base of the manubrium is broad, quadrangular, attached to the subumbrella along the arms of a perradial cross,

so that there are four triangular pouches between the dorsal wall of the stomach and the subumbrella (see the textfig. 3, which is a copy of a drawing made from a specimen from the "Michael Sars" and destined for my paper on the material of that expedition). The mouth-tube is quadrangular, very wide. The edge of the mouth is somewhat crenulated, and the corners are a little dilatated, forming four short, simple lips. The length of the manubrium is variable; it never reaches the opening of the bell cavity, and in most specimens its length is less than $\frac{2}{3}$ of the depth of the bell-cavity; this variation may depend on the state of contraction. There are four radial canals. The proximal part ($\frac{1}{2}$ — $\frac{2}{3}$) of each radial canal is wide and contains the gonads, the distal part is straight and narrow and communicates with the narrow circular vessel. The proximal part of the radial canal is funnel-shaped, communicating with the stomach by a perpendicular slit, somewhat broader at the top than at the bottom. A transverse section of the gonadal part of the radial canal is pear-shaped in the

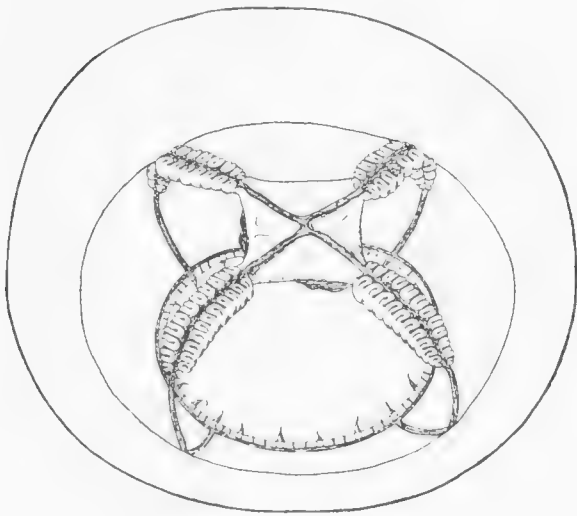


Fig. 3. *Chromatonema rubrum* Fewkes, seen obliquely from the top.

proximal part, nearly circular in the distal part. The line along which the gonadal part of the canal is attached to the subumbrella sends out a number of short lateral branches, so that the attachment of the dorsal wall of the canal has the shape of a pinnate figure (Plate I, fig. 1 and textfig. 3). Occasionally this figure is somewhat irregular, or it may be more or less zig-zag-shaped. Each of the radial canals contains two rows of sack-shaped gonads, attached to the dorsal wall of the canal in the spaces between the above-mentioned lateral branches of the line of attachment and hanging down into the cavity of the canal. The surface of a gonadal sack is covered with a thin entodermal epithelium (see Plate I, figs. 5, 6, 7, and 8), and each sack has a narrow ectodermal lumen communicating with

the bell cavity through a fissure in the dorso-lateral wall of the canal (Plate I, figs. 4, 6, and 8). In view of the scarcity of room, the gonads of the two sides of the canal are more or less regularly alternating (Plate I, figs. 5 and 6). The number of gonads varies from 10 to 16 on either side of the canal. The side-walls of the canal are, as a rule, tightened closely over the gonads so that the wall becomes faintly lobed or undulated. In the upper part of the lateral walls of the canal (outside the gonads) the entoderm consists of one layer of cubical or cylindrical cells (Plate I, figs. 5 and 7). In the funnel-shaped part of the canal the lower parts of the lateral walls, which are not pressed by the gonads, are covered with a thicker entoderm, consisting of several layers of cells (Plate I, fig. 7); evidently the digestion of the food takes place in this part of the radial canal. In larger specimens some of the proximal gonads are frequently developed in the dorsal wall of the stomach on either side of the cross-arms.

There are about 20—24 solid tentacles, all of the same shape and size; the tentacular bulb is hollow, conical, with a heart-shaped base. There is no trace of a basal spur. The tentacles may be spirally coiled (Plate I, fig. 2). In a contracted state the tentacles are deeply and closely transversally

wrinkled. The tentacles seem to be fairly long, but owing to the state of preservation the exact length cannot be stated. Between every successive pair of tentacles there are two (rarely one) appendages which are, I think, homologous with the cordyli of the other *Laodiceidae*. These cordyli are cylindrical or somewhat spindle-shaped, provided with a cluster of nematocysts in the distal end (Plate I, figs. 2 and 3); they are hollow and consist of a thin ectodermal epithelium and a thick entoderm of cubical cells in a single layer, enclosing a central lumen, which communicates with the circular vessel. The cordyli are translucent and colourless. — The velum is thin and narrow.

The colour of the manubrium, the radial canals, the circular vessel, and the tentacles is brightly orange or brick-red; moreover the tentacular bulbs contain a brownish entodermal pigment-mass. The gonadial sacks are white.

Dimensions. — The largest specimen, which I have seen ("Michael Sars" Stat. 84, 1910), is about 27 mm in diameter and about 22 mm high; it has about 24 tentacles and about 16 gonads on either side of each of the radial canals. In the Davis-Strait the species does not seem to grow to such large dimensions, the largest specimen from that area, a fully mature female individual ("Tjalfe" St. 336), being 17 mm wide, 14 mm high, with 18 tentacles, and with 13–14 gonads on either side of each radial canal. A male specimen from the Irminger Sea ("Thor" Stat. 180, 1904) shows the following dimensions: diameter 14 mm, height 12 mm, length of the gonadial part of the radial canals 6 mm, breadth of the same $2\frac{1}{2}$ mm, length of the distal narrow part of the radial canals $3\frac{1}{2}$ mm, 12 pairs of gonads on each radial canal, number of tentacles not stated.

Distribution. — Widely distributed in the deep parts of the northern Atlantic north of about 40° N. Towards the North the distribution is limited by the submarine ridge Scotland—Faeroe Islands—Iceland—Greenland—Baffin Land. The northernmost locality is: Lat. 65° N., Long. 54° W. (Møller), southernmost: Lat. $39^{\circ} 52'$ N., Long. $69^{\circ} 45'$ W., westernmost: Lat. $39^{\circ} 57'$ N., Long. $70^{\circ} 15'$ W., easternmost: Lat. $61^{\circ} 15'$ N., Long. $9^{\circ} 35'$ W.

Bathymetrical Distribution. — The species occurs almost exclusively in the deeper strata. Most specimens have been caught with instruments for pelagical fishing with 1000–3000 m wire out, i. e. about 600–2000 m below the surface. During the Atlantic expedition of the "Michael Sars" in 1910, however, a specimen was taken by a haul with 100 m wire (stat. 81, Lat. $48^{\circ} 02'$ N., Long. $39^{\circ} 55'$ W.), and in one case the species has even been taken with a hand-net at the surface, *viz.* off the west-coast of Greenland by H. P. C. Møller (see below).

The first published description and figure of this medusa were given by Fewkes (1882). But the species has been figured and described many years before, though that figure as well as the description seems to have disappeared.

In the Zoological Museum of the University of Copenhagen I have found a specimen, collected by H. P. C. Møller off the west-coast of Greenland. Though only slight traces of the gastrogenital organs are left, these slight traces in connection with the tentacles, which are fairly well preserved, partly expanded, and the entire shape of the medusa, with its very thick gelatinous substance, put it beyond doubt that the specimen must be referred to the species *Chromatonema rubrum*. The specimen was in a glass-tube with a label of the content shown on p. 10. The Zoological Museum possesses a large number of notes and drawings made by H. P. C. Møller, who was inspector in Greenland for some

years about 1840. On his journeys he made considerable zoological collections, particularly of molluscs, and put down his observations in his journals. While looking through these old papers I succeeded in finding the "*Oceania cardinalis*" mentioned in a journal from 1843; among some other notes from June 13th is the following: "June 13th, off Napparsok. Last night the weather was completely calm, and with the hand-net several things were fished to me at a distance from the land of about 40 miles, to wit: a remarkably pretty small Acaleph, which I have not seen before, and which I have drawn and

<i>Oceania cardinalis</i> 13. Juni. Sukkertopp. Sp. F. Journ. 76. III fig. A. Møller.	described this afternoon (provisionally I will call it <i>Oceania cardinalis</i>) . . ." Now was the question: where are that drawing and description? With the exception of the date and the locality, the marks on the label could give me no information. At first I could not even understand the significance of these marks, until I found, that they are partly due to erroneous copying: "Sp. F Journal" ought to be "Sp. S. Journal", i. e. "Spanske Sø Journal" (Møller calls the Atlantic with the name of Spanske Sø (Spanish Sea), and one of his journals bears that title); and "76" is a mistake for "Tb", i. e. "Tabula". And when I found "Spanske Sø Journal Tab. III, fig. A" I saw a drawing of some crustacean. It is evident, however, from the journal of 1843 that a description and drawing must have been made, but in spite of keen searching I have not found them. It is probable, however, that they have disappeared very soon, because the species is not included in Mörch's list of the Acalephs of Greenland, 1857. The species mentioned in that list have been derived "partly from descriptions in Fabricii Fauna Groenlandica, partly from various posthumous drawings of H. P. C. Møller" (loc. cit. p. 98).
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This find is of considerable interest, because it is the only time the species has been found at the surface and because the said locality is the northernmost place, where the species has hitherto been found. Napparsok is on the west-coast of Greenland a little south of Sukkertoppen. According to the quoted journal of Møller the position of the locality must be: Lat. 65° N., Long. 54° W.

The description of Fewkes is based upon 7 specimens, found during the investigations of the U. S. Fish Commission off the southern coast of New England in 1881, stat. 936 and 954. These stations are near the northern limit of the Gulf-Stream. The depth in which the specimens were taken, is not seen from the available data. Fewkes's description and figure are very deficient, probably owing to the bad state of preservation of the specimens. The gonads are said to occupy the proximal one-third of the radial canals, and Fewkes speaks about large white eggs (which evidently mean the white gonadial sacks), which, according to the figure, are placed irregularly within the "gonads". In every other respect the specimens, examined by me, agree so well with the description and figure given by Fewkes that I have not the slightest doubt, but that they belong to the same species. As to the systematical position of the medusa, Fewkes states that it is "apparently allied to *Staurophora*", but that the determination of its exact position is difficult; he will, therefore, provisionally call it with the name of *Chromatonema rubrum*, till its position can be fixed.

Mayer (1910) quotes the description of Fewkes and places the species within the genus *Thaumantias*.

"Den 13. Juni, paa Høiden af Napparsok. Inat var det aldeles stille og der blev da med Ketzeren fanget adskilligt til mig i en Afstand fra Landet af en halv Snees Mile, nemlig en udmærket smuk lille Acaleph, som jeg ikke før har seet, og i Eftermiddag har tegnet og beskrevet (jeg vil foreløbig kalde den *Oceania cardinalis*) . . .".

During the cruise of the "Tjalfe" to the west-coast of Greenland in 1909 seven medusæ were found in deep water in the Davis Strait; they were identified by me as belonging to the species here dealt with and shortly mentioned with the name proposed by Mayer, *Thaumantias rubrum* (Kramp 1913), and with the same name I included the species in my list of the medusæ of Greenland in "Conspectus Faunæ Groenlandicæ" (Kramp 1914). A more detailed description of this interesting medusa was postponed, till I had examined the specimens, taken on the "Michael Sars" North-Atlantic Deep-Sea Expedition 1910; these specimens had already arrived to me in the Zoological Museum. As my paper on the "Michael Sars" medusæ has not yet been printed (cf. p. 1), I have given the description in extenso in the present paper and, moreover, added several new observations, made on the material from the "Tjalfe" and on two specimens collected during the cruise of the "Thor" in 1904. During the cruise of the Norwegian motor-schooner "Armauer Hansen" in the Atlantic in 1913 5 specimens of the same species were found, which I had the opportunity of examining in Bergen in 1916.

Altogether 34 specimens of this medusa are known up to now. 27 of these specimens have been at my disposal for examination.

In the following complete list of the localities, where the species has been found hitherto, the localities are arranged in the following manner: 1. the Greenland occurrences from the North towards the South, 2. the Atlantic occurrences from the West towards the East.

Lat. 65° N., Long. 54° W., about 40 miles west of Napparsok on the west-coast of Greenland. June 13th 1843. Surface. H. P. C. Møller. — 1 specimen.

Lat. 64°06' N., Long. 55°18' W., Davis Strait. May 8th 1909. Depth 1046—1100 m. Ringtrawl, 1200 m wire. "Tjalfe" stat. 336. — 4 specimens, 11—17 mm wide with 15—18 tentacles (for further details, see Kramp 1913 p. 267).

Lat. 63°18' N., Long. 54°55' W., Davis Strait. May 7th 1909. Depth 1300 m. Ringtrawl, 1530 m wire. "Tjalfe" stat. 333. — 3 specimens, 9—15 mm wide.

Lat. 39°57' N., Long. 70°15' W., 91 miles S $\frac{1}{2}$ E of Martha's Vineyard, New England. August 23rd 1881. Depth 1174 m (642 fms.). U. S. Fish Comm. stat. 954. (Fewkes 1882). — 2 specimens.

Lat. 39°52' N., Long. 69°45' W., 104 $\frac{1}{2}$ miles S. by E. $\frac{1}{2}$ E. of Martha's Vineyard, New England. August 4th 1881. Depth 1289 m (705 fms.). U. S. Fish Comm. stat. 936. (Fewkes 1882). — 5 specimens.

Lat. 42°59' N., Long. 51°15' W., southern edge of the Newfoundland Bank. June 30th 1910. Depth 1100 m. Ringtrawl, 700 m wire. "Michael Sars" stat. 70. — 1 specimen, diameter 23 mm.

Lat. 47°34' N., Long. 43°11' W., eastern slope of the Newfoundland Bank. July 11th 1910. Depth about 2000 m. "Michael Sars" stat. 80. — a. Young-fish trawl, 1000 m wire. 2 specimens. — b. Ringtrawl, 1500 m wire. 2 specimens.

Lat. 48°02' N., Long. 39°55' W. July 12th 1910. "Michael Sars" stat. 81. — a. Ringtrawl, 100 m wire. 1 specimen. — b. Young-fish trawl, 1000 m wire. 1 specimen, diameter about 17 mm, about 20 tentacles. — c. Young-fish trawl, 2000 m wire. 1 specimen, diameter 16 mm.

Lat. 48°24' N., Long. 36°53' W. Juli 13th 1910. "Michael Sars" stat. 82. — a. Young-fish trawl, 1000 m wire. 1 specimen, diam. 21 mm. — b. Young-fish trawl, 2000 m wire. 1 specimen.

Lat. $48^{\circ}04'$ N., Long. $32^{\circ}25'$ W. July 15th 1910. "Michael Sars" stat. 84. — a. Ringtrawl, 2500 m wire. 1 specimen, diam. 26 mm. — b. Young-fish trawl, 3000 m wire. 1 specimen, diam. about 27 mm, about 24 tentacles.

Lat. $54^{\circ}51'$ N., Long. $28^{\circ}15'$ W. July 17th–18th 1913. 1000 m wire. "Armauer Hansen" stat. 9. — 3 specimens: 1. Diam. about 17 mm, three-rayed. 2. Diam. 19 mm, height 15 mm, 20 tentacles. 3. A large, defect specimen.

Lat. $54^{\circ}05'$ N., Long. $26^{\circ}08'$ W. July 15th 1913. 1000 m wire. "Armauer Hansen" stat. 7. — 2 specimens, diam. 18–22 mm.

Lat. $61^{\circ}34'$ N., Long. $19^{\circ}05'$ W., Irminger Sea. July 10th 1904. Depth 2160 m. Young-fish trawl, probably 1800 m wire. "Thor" stat. 180 (04). — 1 specimen, diam. 14 mm.

Lat. $61^{\circ}15'$ N., Long. $9^{\circ}35'$ W., north-west of the Farøe Bank. May 22nd 1904. Depth 872–970 m. Young-fish trawl, 1000–1700 m wire. "Thor" stat. 99 (04). — 1 specimen, diam. 15 mm, about 16 tentacles.

The specimens from the "Michael Sars" and the "Armauer Hansen" are in Bergens Museum, the specimens from the "Thor" and the "Tjalfe" are in the Zoological Museum of Copenhagen.

Among the 5 specimens from the "Armauer Hansen" two are abnormally developed. One specimen from stat. 9 has only three radial canals; a specimen from stat. 7 shows the following features: It is a female individual, 22 mm in diameter. One of the four radial canals bifurcates at the point of issue from the stomach, forming two complete gonadial systems; at the distal ends of these the two branches of the canal unite once more, so that the distal part of the canal, free of gonads, is simple. Two others of the canals, otherwise normally shaped, converge very much in their distal parts and reach the circular vessel so near each other, that only one tentacle finds room between them.

The distribution of *Chromatonema rubrum* (see Chart I) is true oceanic and extends over the deep basins of the North-Atlantic on both sides of the submarine ridge which divides the Atlantic into a western and an eastern basin. The distribution of the species in the western basin extends northwards to the southern slope of the submarine ridge between Greenland and Baffin Land. In the eastern basin the north-limit of the distribution is the Wyville Thomson ridge. With two exceptions, viz. Møller 1843 (see below) and "Thor" Stat. 99 (depth 872–970 m), all of the localities are from outside the 1000 m line. The specimens mentioned by Fewkes were taken on the slope outside the coast of New England south of Cape Cod. The "Michael Sars" found the species on the southern slope of the Newfoundland Bank (depth 1100 m) and east of the same bank (depths more than 2000 m). The specimens brought home by the "Armauer Hansen" were found near the 3000 m line, and by the "Thor" the species was found outside the 2000 m line south of Iceland (stat. 180), and near the 1000 m line north-west of the Farøe Bank (stat. 99). The "Tjalfe" found it between 1046 and 1300 m in the Davis Strait.

The species has mostly been found far below the surface of the ocean, between 600 and 2000 m, i. e. in the true oceanic water. Thus in the Gulf-Stream area the species does not, as a rule, rise to the water-masses of that current, but keeps itself in the deeper and colder water layers. The "Michael Sars" stat. 70 on the southern edge of the Newfoundland Bank is north of the northern limit of the Gulf-Stream; here a specimen was caught about 400 m below the surface.

Though the species has, mainly, a bathypelagical occurrence, it may, however, occasionally rise to the upper water layers. On "Michael Sars" stat. 81 a specimen was fished by the ringtrawl with 100 m wire in water of a fairly high temperature (about 13° C).

More astonishing is the find, made by Møller, off the west coast of Greenland (see above, p. 9). It is a well-known fact that oceanic deep-sea organisms are occasionally carried towards the west coast of Norway and found there near the shore and in the upper water layers. Similar pheno-

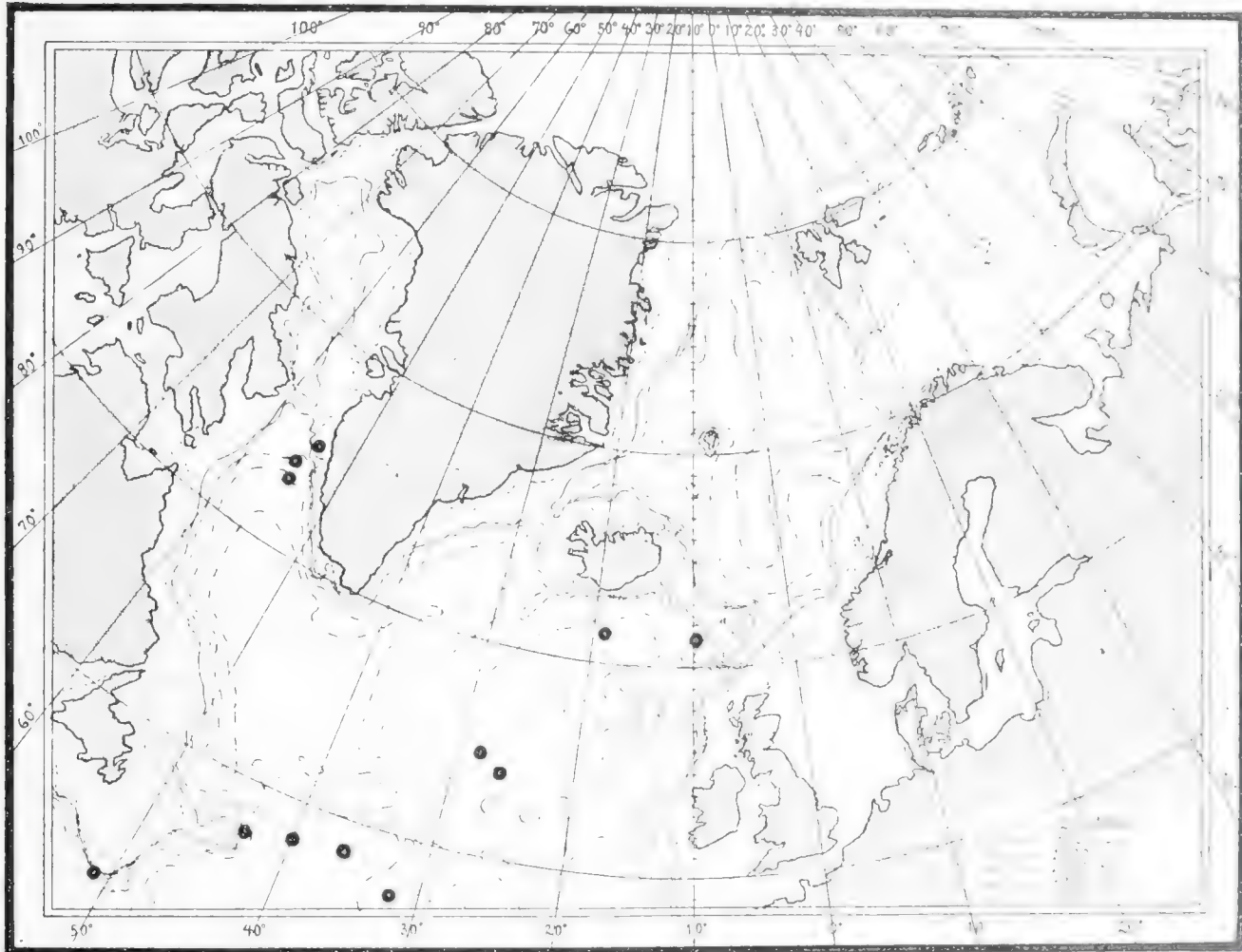


Chart I. Occurrence of *Chromatonema rubrum* Fewkes in the northern Atlantic

mena have been observed on the west coast of Greenland, and this may account for the appearance of this oceanic deep-sea medusa comparatively near the coast and swimming at the surface of the water.

The hydroid stage is unknown, and no young stage of the medusa has been observed: it is impossible, therefore, to state, or even to guess, anything with regard to the development of the species.

Related Species. — Bigelow (1909) has described a similar medusa from the eastern tropical Pacific (the Humbolt-Current off the coast of Peru, in intermediate strata). He called it *Ptychogena erythronon*. Bigelow possessed a series of specimens in different stages of growth, the largest being 38 mm in diameter by 25 mm high. The general appearance of the species bears a striking resem-

blance to that of *Chromatonema rubrum*. The largest specimens have as much as about 64 tentacles; the tentacle bulbs have exactly the same shape as in *Chromatonema rubrum* (op. cit. Plate 39, fig. 5). According to the description Bigelow's species possesses both cirri and cordyli. Only a few cirri were present in his specimens; they are cylindrical and provided with a cluster of nematocysts in the distal end. The cordyli are spindle-shaped and carry no nematocysts. One or two cordyli are present between every two successive tentacles. As mentioned above the cordyli of *Chromatonema rubrum* may be cylindrical or more or less spindle-shaped, in both cases provided with nematocysts, and they are situated in a manner very similar to the arrangement of the cordyli described by Bigelow. The "cordyli" of "*Ptychogena erythrogonon*" are undoubtedly homologous with the cordyli of *Chromatonema rubrum*; as to the homologies of the "cirri" of the former I am not quite sure; the drawing of a single "cirrus" (Plate 38, fig. 9) recalls the cylindrical form of cordyli in *Chromatonema rubrum*, only a little more lengthened and somewhat more heavily armoured with nematocysts; in fig. 5 of Plate 39, however, the name of "cirrus" is attached to an organ which is undoubtedly a young tentacle.

As in *Chromatonema rubrum*, the base of the manubrium of "*Ptychogena erythrogonon*" is quadrate and attached to the subumbrella along the arms of a perradial cross. The mouth-tube is said to be barrel-shaped, while I have described it as being quadrangular in *Chromatonema rubrum*; but it is very likely, that the mouth-tube of the last-named species may attain a circular outline when fully expanded; such is the case in several other species, in which the stomach is quadrate when not expanded. The shape of the radial canals and the gonads of "*Ptychogena erythrogonon*" is exactly as in *Chromatonema rubrum*, the radial canals having "developed a series of short lateral diverticula along the narrow lines by which they are attached to the subumbrella (Plate 39, fig. 2). The main bodies of the canals, however, are so stout that they extend out as far as the ends of these short branches. The gonads develop in the spaces between the diverticula, and are confined to the aboral surfaces of the canals close to the subumbrella ..." (op. cit. p. 151). The distal narrow part of the radial canal is shorter in "*Ptychogena erythrogonon*" than in *Chromatonema rubrum*. — The colour seems to be the same in both species. — The two species are undoubtedly nearly related and must be referred to the same genus. In fact, I can see no other noticeable differences than the want of nematocysts in the cordyli of the Pacific species, and the size, *Chromatonema rubrum* reaching maturity when about 20—24 mm in diameter with about 20—24 tentacles, whereas *Chromatonema erythrogonon* grows to a larger size and may possess 64 tentacles when fully developed.

Another similar form is described by Vanhöffen (1911) as *Ptychogena Hertwigi*, found in the Indian Ocean by the German deep-sea expedition. Vanhöffen describes his species as very like *Ptychogena erythrogonon* Bigelow, but still larger, 50 mm in diameter, yet with a smaller number of tentacles, viz. 20. It has no cordyli but 5 cirri between each successive pair of tentacles. The "cirri", as shown in the figure in the text, seem to be partly cylindrical, partly somewhat club-shaped, partly spindle-shaped. According to the coloured figure (Taf. XXII, Fig. 9) the gonads reach only to the middle of the radial canals. Also this species is undoubtedly nearly related to *Chromatonema rubrum* Fewkes and belongs to the same genus.

Further investigations will show whether the three species mentioned are distinct or only local varieties of one and the same species, viz. *Chromatonema rubrum* Fewkes.

Table I. Synoptic Table of the Species of *Chromatonema*.

	<i>C. rubrum</i> Fewkes	<i>C. erythrogonon</i> Bigelow	<i>C. hertwigi</i> Vanhöffen
Diameter of full-grown medusa	24-27 mm	38 mm	50 mm
Number of tentacles in full-grown medusa	ca. 24	ca. 64	20
Number of cordyli between each successive pair of tentacles	2 (1)	1 (2)	5
Occurrence	Northern At- lantic Ocean	Eastern tropical Pacific	Indian Ocean

Systematical Position. — The structure of *Chromatonema* presents, in several regards, a considerable resemblance to the members of the family *Laodiceidae* previously known, particularly to the genera *Laodicea* and *Ptychogena*. In all of the three genera the manubrium has the same shape: the square stomach, the broad base of which is attached to the subumbrella along the arms of a perradial cross; the short, wide mouth-tube, and the folded mouth-edge, in the four corners of which lips are just indicated. Common for the three genera is, moreover, the structure of the four radial canals; the proximal part of each of the canals contains the gonads; the ventral part of this gonadial part is funnel-shaped and is the proper digestive part of the canal. In *Chromatonema* as in *Ptychogena* the dorsal line of attachment of the radial canal to the subumbrella is pinnate, and in older individuals of all of the three genera the proximal part of the gonads may be developed within the corners of the stomach in the dorsal wall of the latter on both sides of the arms of the perradial cross. But with regard to the structure of the gonads *Chromatonema* presents a considerable difference, not only from *Ptychogena* and *Laodicea*, but from all other Leptomedusæ. As described above each of the radial canals in *Chromatonema* carries two rows of sack-shaped gonads, completely independent of one another. In all other Leptomedusæ each radial canal bears either two lateral gonads, forming two continuous masses in the ectoderm of a certain part of the lateral walls of the canal, or only one gonad completely surrounding a shorter or longer part of the canal. (A special case is the gonads of certain species of *Eutima*, being transversally divided into two separated pairs of gonads, one pair on the subumbrella, one pair on the stomachal peduncle). In some forms the gonadial bands are straight and linear, in others they are more or less undulated or folded. In *Laodicea* the lateral walls of the gonadial parts of the radial canals have a number of short lateral pouches; in *Ptychogena* these pouches are much more highly developed and have attained the shape of vertical lamellæ, the dorsal edges of which are attached to the subumbrella; but still there is only one gonad on each side of the canal; there is only one gonadial band, but it is highly folded. In *Staurophora* the gonads have a similar structure, but the folding is still more complicated.

The structure of the gonads of a *Chromatonema* and a *Ptychogena* may be illustrated by a diagrammatic figure as the textfig. 4. This diagram corresponds to that by which Hartlaub (1914, p. 347) illustrates the typical folding of the gonads in the two groups of *Tiaridae*, viz. the *Calycoptidae* and the *Neoturridæ*. It is not difficult to refer the two types to a common

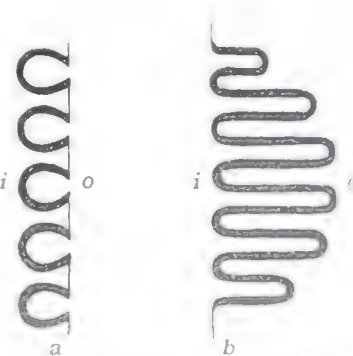


Fig. 4. Diagrams, showing the structure of the gonads in *Chromatonema* (a), and *Ptychogena* (b). — *i* inner side.

ground-plane, and though the peculiar structure of the gonads of *Chromatonema* places that genus in opposition to the other members of the family *Laodiceidæ*, this structure does not contradict the supposition of a generic relationship.

The parallel between the structure of the gonads of *Chromatonema* and of the *Tiaridæ* mentioned above is hardly a casual one. There is, in fact, a striking resemblance between the gonads of *Chromatonema* and the eight adradial rows of gonadal sacks, communicating with the bell-cavity through transversal fissures in the outer surface of the manubrium in a *Calyropsis* (see the figure of Bigelow, copied by Hartlaub, 1913, p. 347, and the transversal section, Vanhöffen, 1911, Textfig. 10a, p. 216, copied by Hartlaub, 1913, p. 348. Compare also Hartlaub's Fig. 238, (1913, p. 287) of the gonads of a young *Leuckartiara octona*, seen from the inner side of the manubrium). The importance of the resemblances between the gonads of the *Tiaridæ* and the gonads of *Chromatonema* and the other *Laodiceidæ* is mentioned above in the introduction to the family *Laodiceidæ* (pp. 6—7). The marginal appendages of *Chromatonema* and their relations to the corresponding organs of the other *Laodiceidæ* and the *Tiaridæ* were also mentioned above.

Thus my considerations with regard to the systematical position of *Chromatonema* lead to the result, that it belongs to the family *Laodiceidæ*, among which it takes a low position, presenting several features pointing to the connection with the *Tiaridæ*. Its position among the *Laodiceidæ* is, however, not only a low, but also in certain regards a singular position, particularly owing to the peculiar structure of the gonads, and it seems probable that the genus has arisen from some other group of *Tiaridæ* than the predecessors of the other members of the *Laodiceidæ*.

Genus *Laodicea* Lesson.

Laodicea undulata (Forbes & Goodsir).

Plate II, figs. 1—8.

?*Medusa cruciata* Forskål 1775. Descriptiones Animalium, p. 110. — 1776. Icones rerum naturalium. Tab. 5, Fig. A.

Thaumantias undulata Forbes and Goodsir 1851. — Transact. Royal Soc. Edinb. Vol. XX, p. 313. Plate 10, fig. 7.

— *mediterranea* Gegenbauer 1856. — Zeitschr. wiss. Zool. Bd. VIII, p. 237. Taf. 8, Fig. 1—3.

Laodicea calcarata A. Agassiz, in L. Agassiz 1862. Contrib. Nat. Hist. U. S. Vol. 4, p. 350.

Laodice ulothrix Haeckel 1879. System d. Medusen, p. 133. Taf. 8, Fig. 5—7.

Laodicea marama A. Agassiz and Mayer 1899. Acalephs, Fiji Islands. — Bull. Mus. Comp. Zool. Vol. XXXII, p. 162. Plate 3, figs. 7—8.

Laodice indica Browne 1905 b. — Pearl Oyster Fisheries, Suppl. Rep. 27, p. 136. Plate I, fig. 5; Plate IV, figs. 7—11.

— Browne 1907. Revision of the ... *Laodiceidæ*. — Ann. Mag. Nat. Hist. Ser. 7, Vol. XX, p. 460.

Laodicea cruciata Mayer 1910. Medusæ of the World, p. 201. Textfigs. 104—105. Plate 21, figs. 4 and 5; Plate 22, figs. 2—6; Plate 23, figs. 1—3.

Bigelowi Neppi et Stiasny 1911. Zool. Anz. Bd. 38, p. 396.

- ? *Laodicea fijiana* A. Agassiz and Mayer 1899. — Bull. Mus. Comp. Zool. Vol. 32, p. 163. Plate 3, figs. 9—10.
 ? *Laodice* — var. *indica* Maas 1905. Craspedote Medusen d. Siboga-Exped. — Siboga-Exped.,
 Monogr. X, p. 25. Taf. 2, Fig. 14—15; Taf. 5, Fig. 32—35.
 ? — *Maasii* Browne 1907. Revision of the ... Laodiceidæ. — Ann. Mag. Nat. Hist. Ser. 7. Vol.
 XX, p. 466.
 ? — *maasi* Vanhöffen 1911. — Deutsche Tiefsee-Exped. Bd. 19, p. 221

Description: The bell somewhat flatter than a hemisphere. The gelatinous substance not very thick, about 2—3 mm at the apical point, evenly diminishing in thickness towards the bell-margin. The diameter of the bell is usually about 25 mm, but it may amount to 37 mm. The stomach is quadrate, spacious; its diameter is about one-fourth of the diameter of the bell. The stomach is fairly short, and the walls are rather thin. The mouth edge is folded in large folds; lips are just indicated, the four corners of the mouth being a little dilatated. The mouth-edge bends outwards, forming a narrow, outturned edge. The dorsal wall of the stomach is attached to the subumbrella along the arms of a perradial cross, four flat, triangular pouches being formed between the dorsal wall of the stomach and the subumbrella. The figure of attachment is, however, in several cases not exactly cross-shaped, but the four cross-arms meet somewhat obliquely (see Plate II, fig. 2). When seen from the mouth the cross has the appearance of four concurrent grooves. Near the centre of the stomach these grooves are open, but before they reach the corners of the stomach each of the grooves becomes transformed into a closed canal, on account of the sides of the groove being developed into two folds meeting each other from both sides, frequently after a wavy line (Plate II, figs. 2 and 3).

There are four radial canals, attached to the subumbrella by a very narrow line, straight or slightly sinuous. The distal part (2—4 mm) of each of the canals is free of gonads and communicates with the narrow circular vessel. The main part of the canal is occupied by the gonads, forming two lateral bands, provided with a number of short, rounded lateral extensions, usually 6—8 on each side of each of the canals. In fully developed individuals the breadth of the gonadial part of a radial canal is about 3 mm. The gonads commence, in well-developed specimens, at a considerable distance within the corners of the stomach, at the same point where the four dorsal grooves turn into closed canals (see Plate II, fig. 2). The gonads occupy only the dorsal part of the lateral walls of the canal; below the gonadial part there is a thin-walled part, which opens like a funnel into the corner of the stomach; this funnel-shaped part is separated from the space between the gonads by two lateral longitudinal folds, continuations of the folds along the dorsal grooves in the stomach, mentioned above (Plate II, figs. 2 and 3). At the distal end of the gonads the separation between the dorsal (gonadial) and the ventral (funnel-shaped) part is, as a rule, not complete. Microtome-sections demonstrate, that the ectoderm is quite thin in the gonadial part of the wall, but much more highly developed in the walls of the funnel-shaped part; we must suppose, therefore, that the digestion of the food takes place in the latter.

The bell-margin carries a very large number of tentacles; in well-sized specimens the number amounts to about 600. In well-preserved specimens the tentacles are, usually, as long as the bell-radius; the distal end is spirally coiled. The tentacles are hollow. Tentacular bulbs are but slightly indicated, the proximal part of the tentacles being a little inflated. The ectoderm of the basal bulb is

thin except on the adaxial side, where it is somewhat thickened (Plate II, figs. 5 and 6). The young tentacle issues from the proper margin of the bell and possesses an abaxial entodermal spur-like process, imbedded in the gelatinous substance on the exumbrellular side of the bell-margin (Plate II, fig. 5). During the continuous growth the adaxial side of the basal part of the tentacle grows faster than the outer side, and thereby the point of issue of the tentacle is gradually removed from the bell-margin upwards on the outer side of the bell; older tentacles, therefore, issue from the exumbrella at some distance above the bell-margin (Plate II, figs. 6 and 8). On account of this removal the abaxial part of the tentacular base, which is pushed upwards on the outer side of the umbrella, invests the spur-like process, which at last entirely disappears (Plate II, fig. 6). Accordingly, a "spur" is only present on the young tentacles. The fully developed tentacle turns abruptly outwards and downwards, immediately after leaving the wall of the umbrella. The central canal in the tentacle has not the same width everywhere, but expands and narrows at different points (Plate II, fig. 8); the greatest width is a little outside the point of issue of the tentacle. The course of the canal is approximately central, except in the basal part, where it passes the sharp bend very close to the adaxial side (Plate II, fig. 6). Within the imbedded part of the tentacular base the canal is very narrow and opens in the circular vessel. In young individuals, in which the tentacles are not so densely crowded on the bell-margin, the basal bulbs are fairly broad, all the tentacles issue from the margin itself, and spurs are only just beginning to develop.

A small, dark, sharply defined ocellus is found on the adaxial side of the base of some of the tentacles. The number of ocelli is subject to much variation; as a rule ocelli are found on every 3rd—5th of the tentacles, but they may be found on every 2nd tentacle, rarely on two successive tentacles.

Typical cordyli are situated between the tentacles (Plate II, figs. 5, 6, and 8). The cordyli issue from the bell-margin close by the base of the velum; they are very small, hardly longer than the proximal breadth of a fully-developed tentacle; they have, as a rule, a fairly thick distal part and a very thin peduncle. In some of the cordyli the inner lumen is fairly large, in others it is very narrow or nearly obliterated, being just visible as a fine streak; this variation stands in no relation to the size of the cordylus. Some of the cordyli may be mounted upon fairly large bulbi; in such cases their basal part is turning inwards (adaxially). The number of cordyli is variable and may be a little larger or a little smaller than the number of tentacles. This seems to depend on the stage of development of the individual; in full-grown specimens the number of cordyli is, probably, always the same as the number of tentacles.

The bell-margin also bears fine cirri, which may be spirally coiled, and which are greatly armoured with nematocysts in their distal part. According to Mayer the cirri are "usually somewhat less numerous than the tentacles"; in preserved material, as a rule, only a small number of cirri are left; the material, examined by me, therefore, gives no available information of their number. In badly preserved specimens I have, in fact, been unable to find any cirri at all.

The velum is fairly well-developed; in full-grown specimens it is about 3 mm wide.

The colour is subject to much variation. The manubrium, the gonads, and the tentacular bulbs may be reddish or greenish or nearly colourless. Most of the specimens, examined by me, are reddish, provided that the colour is preserved. In an individual from the "Thor" stat. 72 (1905), the gonads are pale green.

The material contains a number of young individuals, viz. from the "Michael Sars", south of the Myrdalsjokel, Iceland, $17/8$ 1903; from the "Thor" stat. 45 (08), Iceland; from two localities near the Hebrides, "Thor" stat. 8 (08) and 11 (08); and from the Horns Rev light-vessel, west of Jutland, $23/9$ 1912. The smallest specimen is 5 mm wide. These young individuals show that the margins of the dorsal grooves in the wall of the stomach begin at an early stage to develop into folds which meet and transform a part of the groove into a closed canal; further that the gonads first appear near the corners of the stomach and, from these points, develop partly in a centripetal direction towards the centre of the stomach, which is, however, never reached, partly in an outward direction towards the circular vessel, which is, likewise, never reached. At an early stage the transversal folds of the gonads begin to form; in a specimen, 7 mm wide, each of the gonads has 2—3 pairs of transversal folds; in an individual, 9 mm wide, there are 6 pairs of folds on each of the gonads. When the diameter of the bell is about 20 mm, the gonads are somewhat far developed, particularly the female gonads, which already now contain very conspicuous eggs.

The structure, mentioned above: that the ventral, funnel-shaped part of the radial canal is separated from the dorsal gonadial part by two lateral longitudinal folds, does not seem to have been observed by previous authors. In this part of the gastro-genital system there is established a very interesting differentiation into two parts with different functions. The ventral, funnel-shaped part receives and dissolves the organisms, which serve as food for the medusa; they are however prevented from penetrating into the dorsal part between the gonads on account of the longitudinal folds; the dissolved nutritive matter, on the other hand, may pass between the folds into the dorsal part. Probably a part of the food is also digested in the stomach and may, by means of the ciliary motion in the dorsal grooves, be carried into the dorsal part of the radial canal; this part, accordingly, has two functions: to carry the gonads in its lateral walls, and to transport the nutritive substances into the peripheral parts of the canal system.

From what is said above with regard to the development of the gonads, it will be understood, that the length of the distal part of the radial canals free of gonads in proportion to the radius of the bell is considerably larger in young specimens than it is in full-grown individuals. In specimens, about 10 mm wide, the gonads reach to the middle of the radial canals. In full-grown individuals the length of the gonads is very variable. In a specimen, 28 mm wide, from Iceland ("Thor" stat. 241 (09)) the distance from the distal end of the gonads to the circular vessel is 2 mm; in another specimen, 30 mm wide ("Thor" stat. Da. 13 (04)), the length of the gonads is 9.5 mm; they commence 1.5 mm from the centre of the stomach and terminate about 4 mm from the circular vessel; in a specimen, 35 mm wide ("Thor" stat. 180 (04)), the length of the gonads is about 15 mm; they commence very near the centre of the stomach and terminate 2.5 mm from the circular vessel.

The number of tentacles is considerably larger than is usually stated in the literature. It is possible that the locality plays a part in this respect. All the specimens examined by me have been found in the waters around Scotland, the Faeroe Islands, Iceland, Norway, and Denmark. The smallest individual is from the Horns Rev light-vessel, $23/9$ 1912; it is 5 mm wide and has about 48 tentacles, placed at some distance from each other; in accordance herewith the basal bulbs are comparatively broad. Specimens from the waters near the Hebrides ("Thor" stat. 8 (08) and 11 (08)) have, when 7 mm

wide, 100—140 tentacles, and, when 8 mm wide, 160—180 tentacles; in specimens of this size the tentacles are very closely packed on the bell-margin. The number of tentacles increases tolerably proportionally with the diameter of the individual, the average number being as follows:

Diameter of bell 11—15 mm, 230 tentacles				
—	—	16—20	—	290
—	—	21—25	—	390
—	—	26—30	—	440

The largest specimen examined ("Michael Sars" stat. 140 (03), east of the Orkney Islands) is 37 mm wide and has about 500 tentacles; but another specimen, 35 mm wide ("Thor" stat. 180 (04), south of Iceland) has about 620 tentacles; this is the largest number of tentacles, which I have seen in this species.

The number of ocelli is variable. There is an ocellus on, at least, every 5th of the tentacles. Even in one and the same individual the succession of the ocelli is irregular. In a specimen from Iceland ("Thor" stat. 241 (04)), about 25 mm wide, the ocelli are, on the whole, found on every second tentacle; here and there, however, two or even more successive tentacles are provided with ocelli, or ocelli are wanting on two successive tentacles. From the Hebrides ("Thor" stat. 8 (08)) we possess a number of young individuals, among others two specimens, 7 mm wide, with 100—140 tentacles; in one of these specimens the ocelli are fairly regularly distributed on every 2nd tentacle, while in the other specimen ocelli are only found on every 4th to 5th of the tentacles; among two specimens, 8 mm wide, one has an ocellus on every 2nd tentacle, in the other the ocelli are irregularly distributed on every 2nd to every 5th of the tentacles. Specimens from the same locality, 9 and 16 mm wide, have ocelli on about every 2nd tentacle. From the "Thor" stat. 11 (08), somewhat to the west of the Hebrides, we possess several specimens 8—22 mm wide; in most of these specimens there is an ocellus on every 3rd—5th of the tentacles, though in some specimens every 2nd tentacle bears an ocellus. In two specimens from the Orkney Islands ("Thor" stat. 2 (08)), 6—13 mm wide, the ocelli are fairly regularly distributed on every 5th tentacle. Most of the specimens from Iceland have ocelli on every 3rd—5th of the tentacles; in not a few cases, however, there is an ocellus on every 2nd tentacle; this is the case, for instance, in a 12 mm wide individual and in another, 25 mm wide. — It will be seen, from the facts here mentioned, that the number of ocelli stands in no ostensible relation to the size of the individual, nor to the locality, in any case as far as the area here dealt with is concerned.

The question, whether the cordyli may be transformed into tentacles, has been discussed above (p. 5). The number of cordyli has been used as a specific character, undoubtedly incorrectly. It is difficult, on preserved material, to state with certainty the number of cordyli, as they are very apt to drop off on the preservation. With regard to the material, examined by me, the fact is, that in all full-grown or nearly full-grown individuals, sufficiently well-preserved, the number of cordyli is equal to the number of tentacles. Most of the small specimens are badly preserved. In a specimen, 5 mm wide, from the Horns Rev, I have, in some cases, been able to find two cordyli between two successive tentacles.

With regard to the cirri, we may state as in the case of the cordyli: that they frequently dis-

appear on the preservation. In most of the specimens examined by me cirri are completely absent; but in all of the well-preserved specimens a greater or smaller number of cirri are present. In no case I have been able to state the number of cirri.

The Hydroid generation belongs to the genus *Cuspidella*. As to this point, see Browne 1907, pp. 463 ff.

This medusa, fairly large and conspicuous, widely distributed, and frequently occurring in great numbers, has been known from early times, and has been described several times, usually very deficiently, unfortunately, and under many different names. It is, therefore, very difficult to give a reliable list of synonyms. The confusion has been further increased thereby that several species, belonging to quite other genera or families, have been included in the lists, e. g. by Haeckel (1879), as demonstrated by Browne (1896). Among other species, *Thaumantias* (*Cosmetira*) *filosella* Forbes has frequently been identified with "*Laodice cruciata*", and is even found under that name in Bedot: *Histoire des Hydroïdes*¹. Browne has refound the *Cosmetira filosella* of Forbes and demonstrated, that it belongs to quite another group of Leptomedusæ.

If we want to state the correct name of the species, we must do away with all descriptions, older than 1851; they are all so vague, that the species in question cannot be identified with any probability at all.

The generic name *Laodicea* has been established by Lesson (1843) for the "*Medusa cruciata*" Forskål, called by Lesson "*Laodicea crucigera*", and this generic name has been commonly used since that time for the genus here dealt with. The first description of a *Laodicea*, sufficiently clear for identification, is the description of "*Thaumantias undulata*" Forbes and Goodsir 1851² from the west-coast of Scotland. When we admit that none of the forms previously described, which have later on been referred to the genus *Laodicea*, may be identified with certainty, there can be no doubt that, according to the rule of priority, the correct name of the British *Laodicea* must be *Laodicea undulata* Forbes and Goodsir. The next question is, whether there is any reason, in this particular case, to abandon the strict application of the rule, and, as Mayer (1910) prefers, "to retain an old and familiar name rather than to reinstate an unfamiliar one such as *L. undulata*". In order to answer this question, we must see, how the name of *cruciata* has been used in the subsequent period.

The name *Laodicea cruciata* was assigned by A. Agassiz (in L. Agassiz 1860—62, p. 350) to Forskål's medusa, which was, in the same work, identified with *Thaumantias mediterranea* Gegenbauer and joined together with the new species *Laodicea calcarata*, *L. cellularia* (= *Thaumantias cellularia* Haeckel 1879, *Halistaura cellularia* Bigelow 1913), and *L. stauroglypha* (an apocryphal species) to form the genus *Laodicea*. The specific name *cruciata* has not been used at all during the subsequent period until 1879, when Haeckel united several medusæ from the European Atlantic coasts and the Mediterranean under the name of "*Laodice cruciata*". As demonstrated by Browne (1896 p. 482) there is only

¹ In "*Histoire des Hydroïdes*" 6^e période (1891 à 1900), issued 1918, Bedot has separated "*Laodicea cruciata*" from *Cosmetira filosella*, but some of the synonyms, placed under the former, do not actually belong to that species. The "*Irene viridula*" of Garstang 1894 seems to be a real *Eirene*, with distinct stomachal peduncle and with marginal vesicles (according to Garstang's description in the quoted paper, p. 215). — "*Laodice cruciata*" of Haddon (1886 c), Garstang (1894), Herdman (1894 c), Browne (1895, 1896 c, and 1898 a) should be referred to *Cosmetira filosella*.

² The paper was read before the Royal Society of Edinburgh on Jan. 20th and Febr. 3rd 1851 and printed in the *Transact.* Vol. XX, which was completed in 1853.

one single name among Haeckel's 25 synonyms, which really refers to a *Laodicea*, viz. *Thaumantias mediterranea* Gegenbauer. Before Haeckel, accordingly, the specific name *cruciata* was very far from being commonly used or "familiar", and Haeckel's list of synonyms made the confusion as complete as ever. Indeed, I am not able to find a better way out of the mess, than to release altogether the name of *cruciata* and follow the rule of priority, using the name by which the species has first been described in a manner which allows a recognition, viz. *undulata* Forbes and Goodsir. This was proposed by Browne in 1907, and the proposal was adopted by Vanhöffen in 1911 (p. 365).

Then we come to the question of the mutual relation between the different species of the Genus *Laodicea*.

Since new examinations of the medusæ belonging to this group have been carried out in later years (Browne 1907, Mayer 1910), it may be stated, that the Mediterranean "*Thaumantias mediterranea*", Gegenbauer, the North-American-Atlantic *Laodicea calcarata* A. Agassiz, and the Tropical-Atlantic *Laodicea ulothrix* Haeckel are identical with the North-European *Laodicea undulata* (Forbes and Goodsir). Mayer is undoubtedly right, when he refers to the same species the *Laodicea marama* Agassiz and Mayer (from the Fiji Islands), a species which, according to the description (1899) is exactly like a young *undulata*. *L. indica* Browne (from Ceylon) is very like *L. undulata*, from which it is only distinguished (according to Browne 1905 b) "in having no spur at the base of the tentacles, in having larger ocelli, and perhaps in colour and size", characters to which, as will be understood from what is said above, we may hardly assign any specific importance. Cirri are present in *L. indica*, though only in small numbers.

In 1899 A. Agassiz and Mayer described a small medusa from the Fiji Islands, *Laodicea fijiana*; the most characteristic features of this species are the lacking of cirri, the very small number of cordyli, and the gonads which, in spite of the small size of the animal (6 mm), were provided with "complex diverticulæ". Tentacular spurs are not mentioned nor figured. — Maas (1905, Siboga-Exped.) describes a *Laodicea* from the Indian Archipelago and refers it to *Laodicea fijiana*, though it is much larger, being 20 mm wide; he is apt to suppose, however, that it belongs to a local variety, to which he will apply the name of var. *indica*. Browne (1907 p. 466) finds, that there is so much difference between the two forms, that it will be correct, in any case provisionally, to describe that medusa as an independent species, which he calls *L. Maasii*. As the most decisive difference Browne calls attention to the fact, that basal spurs are present on the tentacles of *L. Maasii*, whereas such are not described in *fijiana*. This, however, does not contradict the supposition, that *L. fijiana* may be a young stage of *L. maasii* (it was mentioned above that spurs are not developed in young individuals of *L. undulata* from the northern seas). The length of the gonads in *L. maasii* is highly variable; Maas writes as follows (p. 26): " . . . ich habe jüngere Exemplare gesehen, bei denen die Geschlechtsproducte bis an die Peripherie reichten, und alte mit strotzenden Ovarien, die nur etwa die halbe Länge der Radiärkanäle einnahmen." The length of the gonads can, accordingly, have no great importance for specific distinction. The structure of the gonads involves more difficulty. In *L. maasii* the gonads are provided with simple lateral extensions, whereas in *L. fijiana* the proximal parts of the radial canals "exhibit complex diverticulæ", on which the gonads are situated. This is only a difference in degree, it is true, which has no decisive importance; but, on the other hand, the specimens of *L. fijiana*, in any case the female individuals,

seem to have contained mature sexual products, in so far as "the ova are prominent, and project outward in grape-like clusters over the surface of the genital organs". This, indeed, does not seem to suggest, that we have here to deal with young stages. It is not altogether excluded, however, that such is nevertheless the case; we know other examples, where the eggs of a still young medusa may develop into a considerable size and give the surface of the gonads a rugged appearance (see, for instance, the following pages on *Tiaropsis*). The description, given by Maas, is so clear and excellent, that it cannot be misunderstood. It may be worth while, therefore, to call attention to the fact, that Mayer (1910) identifies the two forms, an apprehension which he has not changed in his later work (1915, p. 200), after having had the opportunity of examining new material of *L. fijiana* from the Torres Straits.

During the German Deep-Sea Expedition a small *Laodicea* was found in the Gulf of Aden; it was 5 mm in diameter and had about 96 tentacles. Vanhöffen (1911) referred this medusa to *L. maasii* Browne. With regard to the size and the distribution of the large ocelli it agrees with *L. indica* Browne, but cirri could not be pointed out with certainty. On the other hand, the presence of spurs on the base of some of the tentacles evinces an agreement with *L. maasii*. It is an interesting fact, that Vanhöffen did only find spurs on the younger tentacles, whereas such were apparently absent in the case of the larger tentacles. Vanhöffen is of the opinion, "dass sämtliche Tentakel einen Sporn haben, dass er nur wegen der Krümmung des Schirmrandes häufig nicht sichtbar ist und besonders bei älteren Tentakeln undeutlich oder verdeckt wird . ." (1911, p. 221). This agrees very well with what I have observed in *Laodicea undulata* (see above). Vanhöffen's medusa reminds one of the *L. bigelowi* Neppi & Stiasny (1911) from the Gulf of Trieste, a small medusa (probably young), 7 mm in diameter with about 70 tentacles, some of which have basal spurs; cordyli, mounted upon small bulbs, are found in somewhat smaller number than the tentacles; cirri are wanting. There can be no doubt of the identity of this species with *Laodicea undulata*.

The three forms of *Laodicea* from the Indo-Pacific region, mentioned above, viz. *fijiana*, *maasii*, and *indica*, are undoubtedly nearly related. Their relation to the European *Laodicea undulata* may, most adequately, be elucidated through a comparison between the latter and Maas's excellent description of "*L. fijiana* var. *indica*" (= *maasii* Browne). The description and figure (Taf. V, Fig. 34) of the flattened, open, square stomach, the four corners of which are drawn out into four "Zipfel", agree exactly with the features found in *L. undulata*. The same holds good with regard to the gonads, which, in the case of the North-Atlantic forms, have not been sufficiently thoroughly described up to now. Maas mentions "Aussackungen, die nicht allein durch Faltung des die Geschlechtsprodukte tragenden Ectoderms bedingt sind, sondern auch durch entsprechende Aussackungen des entodermalen Raumes". Also in this respect we find a complete agreement with the facts, as I have observed them in *undulata*. The length of the gonads is, in *L. maasii*, very variable, being, as a rule, $\frac{2}{3}$ the length of the radial canal, but, in some cases, reaching nearly to the circular vessel. The number of tentacles seems to be somewhat smaller in *L. maasii* than in equally-sized individuals of *L. undulata*; in this regard *maasii* is more in accordance with *calcarata* and *ulothrix*. The shape of the tentacles is exactly as in *undulata*. Ocelli are said to be found on about three-fourth of the tentacles of *maasii*; in *undulata* the number of ocelli is, as mentioned above, very variable. *L. maasii* is said to possess a compara-

tively small number of cordyli; the highly irregular distribution of the cordyli, however, seems to indicate, that the number has been greater in the living animal, but that most of the cordyli have dropped off, as is often the case in preserved material. — Cirri have not been observed in *L. maasii*; it is possible, that cirri are really wanting in this form, but, on the other hand, there is an equal probability of the want being due to the preservation. As mentioned above, cirri were only ostensible in well-preserved specimens of *L. undulata*, and even then but a very small number were left; moreover, it is always very difficult to trace these delicate organs between the densely crowded tentacles. Also the above-mentioned *L. bigelowi* Neppi & Stiasny is said to be devoid of cirri, though its identity with the common European form is beyond doubt. The colour of the radial canals, the gonads etc. of *L. maasii* is light blue to bluish-green, thus particularly in accordance with the colour commonly found in *L. ulothrix*, a colour which may also be met with in others of the Atlantic forms of *Laodicea*. — Altogether, the description, as given by Maas, of the East-Indian medusa presents a correspondence, accomplished into minute details, with *Laodicea undulata* from the north-eastern Atlantic, the only feature of distinction being the want of cirri, a feature which, very probably, is due to preservation.

We still have to mention *Laodicea pulchra* Browne (1902, p. 280) from the Falkland Islands. This medusa grows to the size of 25 mm in diameter; in spite of this considerable size it has only about 50 tentacles; there are usually 3—4 cordyli between each successive pair of tentacles. This is evidently a well-defined form, specifically different from all the forms mentioned above.

Table II. Synoptic Table of the various forms of *Laodicea*.

Name	Occurrence	Size	Cirri	Basal Spurs	Colour
<i>undulata</i>	N.-Atlantic, Europe	large, up to 37 mm	present	present on the younger tentacles	usually reddish or orange, may be brownish, purple, blue or violet
<i>mediterranea</i>	Mediterranean	not stated	present	present	brownish-reddish
<i>bigelowi</i>	Mediterranean	7 mm	absent	present	not stated
<i>calcarata</i>	N.-Atlantic, America	large	present	present	usually dark-yellowish, but very vari- able, reddish, greenish, or blue
<i>ulothrix</i>	Tropical Atlantic	fairly large	present	present, but not on all tentacles	brownish-white, greenish-white
<i>marama</i>	Fiji Islands	5.5 mm	present	not mentioned	bluish or greenish
<i>fijiana</i>	Fiji Islands, Torres Straits	up to 10 mm	absent	not mentioned	bluish, greenish, or violet
<i>maasii</i> (acc. to Maas) ...	Malayan Archipelago	up to 20 mm	absent	present on several tentacles	light blue or bluish-green
<i>indica</i> (Browne)	Ceylon	up to 6 mm	present	absent	not stated
<i>maasii</i> (acc. to Vanh.) ...	Gulf of Aden	5 mm	not stated	present	not stated

The Table II includes all the different forms of *Laodicea* described up to now (except *L. pulchra*), arranged according to their geographical occurrence. It will be seen that all of the forms from the Atlantic-Mediterranean area possess both cirri and tentacular spurs, with the exception of *L. bigelowi* from the Adriatic Sea, in which cirri have not been observed. With regard to the forms from the Indo-Pacific region, the organs in question are said to occur in some forms, whereas they are

wanting in others. The predominant colours of the gastro-genital organs are bluish or greenish in the Indo-Pacific forms as also in the Tropical-Atlantic form, whereas the reddish, yellowish, or brownish colours are predominant in the North-Atlantic forms; blue, green, and violet may, however, also be met with in the latter.

I am inclined to suppose, that all the forms of *Laodicea* described up to now, with the exception of *Laodicea pulchra* Browne, belong to one and the same species: *Laodicea undulata* Forbes and Goodsir, a species which attains its most exuberant development in the North-Atlantic; in the tropical Atlantic, the tropical Pacific, and the Indian Ocean the species is represented by forms, which may be called more or less well-marked local varieties; in some cases the described differences from the typical *L. undulata* may even possibly be due to bad preservation.

If this view be correct, the Geographical Distribution of *Laodicea undulata* is the following:

1) *Atlantic Coasts of Northern Europe*. — (*L. undulata* Forbes and Goodsir). — The occurrence within this area will be discussed in a more detailed way further below.

2) *Mediterranean*. — Neapel, "occasionally during the winter of 1907—08" (*L. cruciata*, Mayer 1910). Messina, winter 1852—1853 (*Thaumantias mediterranea*, Gegenbauer 1856). Triest (*L. cruciata*, Graeffe 1884, *L. bigelowi*, Neppi & Stiasny 1911). Villafranca (*L. cruciata*, Metschnikoff 1886).

3) *Atlantic Coasts of North-America*, south of Cape Cod (*L. calcarata* A. Agassiz). — Naushon, Vineyard Sound, between Delaware Bay and Chesapeake Bay, Woods Hole (A. Agassiz 1865, Hargitt 1904, Mayer 1910, Bigelow 1914 b and 1915). — During the numerous investigations of the "Grampus" in the Massachusetts Bay *Laodicea* was never found. During the investigations in July and August 1913, ranging from Nova Scotia to Chesapeake Bay (Lat. about $44\frac{1}{2}^{\circ}$ to 37° N.) the species was found at four of the southernmost stations, between Delaware Bay and Chesapeake Bay (i. e. Lat. 37° to $38^{\circ}26'$ N.) at the end of July (Bigelow 1915, p. 318 and the list p. 316—317).

4) *Tropical Atlantic* (*L. ulothrix* Haeckel). — Canary Islands (Haeckel 1879, Vanhöffen 1912). Bahamas (Mayer 1904). Tortugas, Florida, common during the summer-months (Mayer 1900).

5) *Fiji Islands*, common in December (*L. fijiana* and *marama*, Agassiz and Mayer 1899).

6) *Torres Straits*, September—October (*L. fijiana*, Mayer 1915).

7) *North-Coast of New Guinea and several places in the Malayan-Archipelago* (*L. fijiana* var. *indica*, Maas 1905, *L. maasi*, Browne 1907).

8) *West-Coast of Ceylon* (*L. indica*, Browne 1905).

9) *Gulf of Aden* (*L. maasi*, Vanhöffen 1911).

All records agree, that this species occurs exclusively in the neighbourhood of the coasts.

Distribution and Occurrence in the north-eastern Atlantic.

The material at my disposal has been collected at 28 different localities, which are here mentioned in the following order: the waters south of Iceland, round Rockall, west, north, and east of Scotland, North-Sea, Skagerrak. (See Chart II p. 26.)

1) — Lat. $64^{\circ}06'$ N., Long. $23^{\circ}14'$ W., Faxebugt, Iceland. July 2nd 1908. Depth 98 m. Young-fish trawl, 65 m wire. "Thor" stat. 45 (08). — 1 specimen, 12 mm wide.

- 2) — South of Myrdalsjökul, Iceland. August 17th 1903. "Michael Sars". — 1 specimen, 17 mm wide.
- 3) — Myri Bugt, Iceland. July 21st 1904. Depth 38 m. "Beskytteren". — 6 specimens, 21—26 mm wide.
- 4) — Lat. $64^{\circ}04' N.$, Long. $15^{\circ}48' W.$, Myri Bugt. July 24th 1904. "Beskytteren". — 2 specimens, 18—22 mm wide.

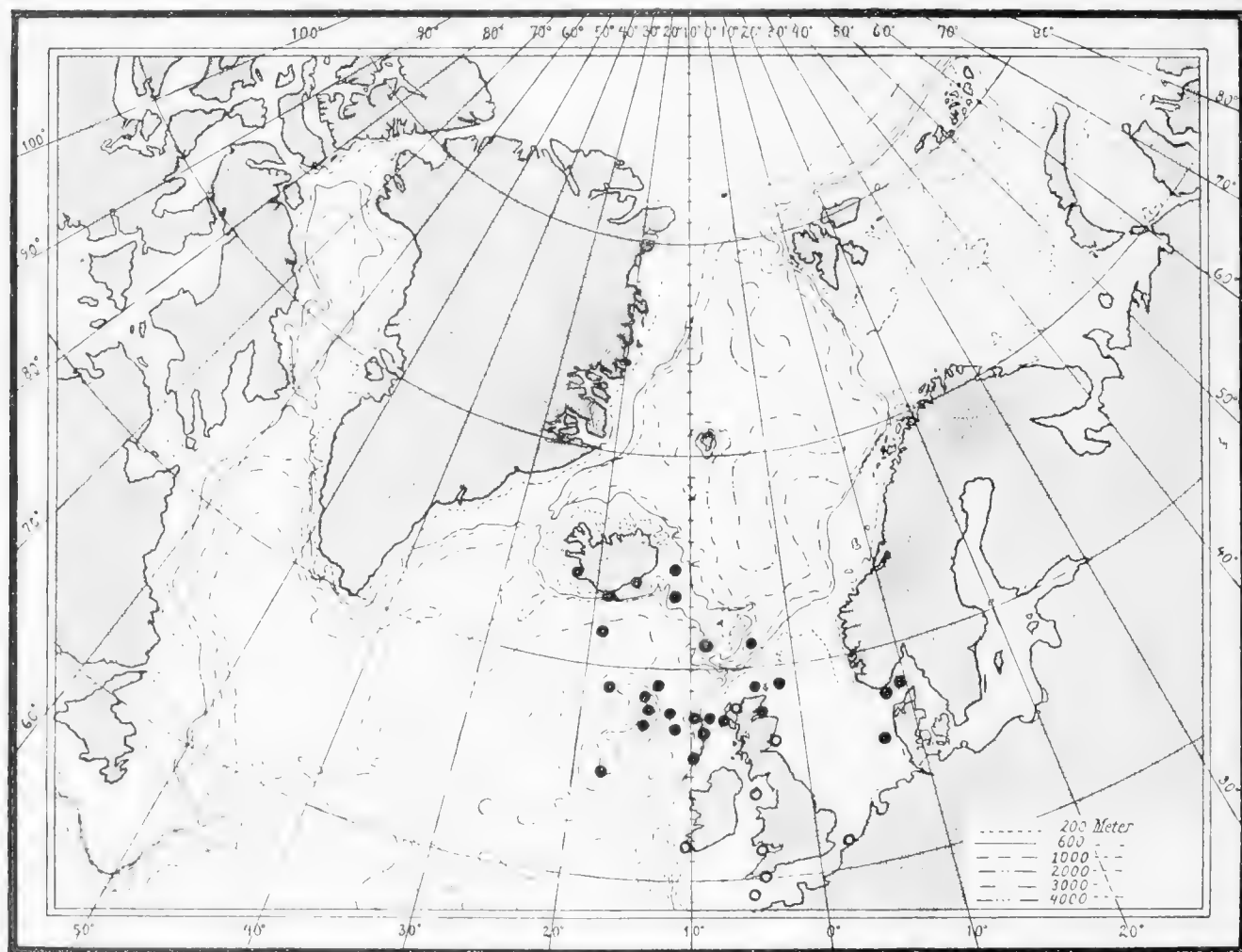


Chart II. Occurrence of *Laodicea undulata* in the northern Atlantic and adjacent waters.

○ Occurrence according to the literature.

- 5) — Lat. $64^{\circ}35' N.$, Long. $11^{\circ}45' W.$, East-Iceland. August 8th 1904. Depth 348 m. Young-fish trawl, 20 or 70 m wire. "Thor" stat. 241 (04). — 2 specimens, 25—28 mm wide.
- 6) — Lat. $61^{\circ}34' N.$, Long. $19^{\circ}05' W.$, south of Iceland. July 10th 1904. Depth 2160 m. Young-fish trawl, 15 or 70 m wire. "Thor" stat. 180 (04). — 1 specimen, 35 mm wide.
- 7) — Lat. $63^{\circ}12' N.$, Long. $11^{\circ}45' W.$, between Iceland and the Faeroe Islands. August 7th 1904. Young-fish trawl, 20 m wire. "Thor" stat. Da 13. — 1 specimen, 30 mm wide.
- 8) — Lat. $59^{\circ} N.$, Long. $18^{\circ} W.$, between Iceland and Rockall. Olrik. — 3 specimens, 22—

9) — Lat. $59^{\circ}07' N.$, Long. $13^{\circ}32' W.$, north of Rockall. Moberg. — 5 specimens, 14 — about 25 mm wide.

10) — Lat. $58-59^{\circ} N.$, Long. $13-15^{\circ} W.$, north of Rockall. Rink 1852. — 5 specimens, about 22 mm wide.

11) — Lat. $57^{\circ}45' N.$, Long. $13^{\circ}40' W.$, near Rockall. August 6th 1910. Young-fish trawl, 50 m wire. "Michael Sars" stat. 99 (10). — 5 or 7 specimens.

12) — Lat. $56^{\circ}58' N.$, Long. $14^{\circ}39' W.$, Rockall Bank. July 7th 1913. "Armauer Hansen" stat. 2. — 200 m wire: 4 large specimens, up to 33 mm wide. — 400 m wire: 1 large specimen.

13) — Lat. $54^{\circ}42' N.$, Long. $18^{\circ}44' W.$, south-west end of Rockall Plateau. July 10th 1913. "Armauer Hansen" stat. 4. — 400 m wire: 3 specimens, two very large, one smaller. — 600 m wire: 1 specimen. — 1000 m wire: 4 large specimens.

14) — East of Rockall. July 28th 1913. "Armauer Hansen" stat. 17. — Surface: 9 full-grown specimens. — 150 m wire: 3 specimens, two very large, one smaller. — 600 m wire: 4 specimens, three large, one smaller. — 1000 m wire: 3 large specimens. — 1300 m wire: 7 specimens, among which are 5 very large, being up to 35 mm wide.

15) Lat. $57^{\circ}03' N.$, Long. $11^{\circ}20' W.$, deep channel east of Rockall, May 28th 1908. Young-fish trawl, 300 m wire. "Thor" stat. 12 (08). — 1 specimen, 26 mm wide.

16) Lat. $55^{\circ}44' N.$, Long. $9^{\circ}35' W.$, north-west of Ireland. June 25th 1906. Depth 1600 m. Young-fish trawl, 350 m wire. "Thor" stat. 89 (06). — 1 specimen, 26 mm wide.

17) — Lat. $57^{\circ}52' N.$, Long. $9^{\circ}53' W.$, deep channel east of Rockall. June 8th 1905. Young-fish trawl, 600 m wire. "Thor" stat. 72 (05). — 1 specimen, about 23 mm wide.

18) — Lat. $56^{\circ}56' N.$, $9^{\circ}01' W.$, west of Scotland. May 28th 1908. Depth 140 m. Young-fish trawl, 65 m wire. "Thor" stat. 11 (08). — 9 specimens, 8–22 mm wide (8, 11, 13, 14, 14, 16, 21, 21, 22 mm).

19) — Near St. Kilda. July 5th 1913. "Armauer Hansen" stat. 1. — Surface: 1 specimen. — 50 m wire: 1 specimen.

20) — Lat. $57^{\circ}36' N.$, Long. $7^{\circ}05' W.$, Little Minch. May 27th 1908. Depth 90 m. Young-fish trawl, 65 m wire. "Thor" stat. 8 (08). — 7 specimens, 7–16 mm wide (7, 7, 8, 8, 9, 11, 16 mm).

21) — Lat. $59^{\circ}00' N.$, Long. $3^{\circ}34' W.$, west of Orkney Islands. May 21st 1908. Depth 66 m. Young-fish trawl, surface. "Thor" stat. 2 (08). — 2 specimens, 6–13 mm wide.

22) — Lat. $60^{\circ}55' N.$, Long. $8^{\circ}56' W.$, Faeroe Bank. August 12th 1902. Depth 130 m. "Michael Sars" stat. 78 (02). — 1 specimen, about 15 mm wide.

23) — Lat. $61^{\circ}04' N.$, Long. $4^{\circ}33' W.$, Faeroe-Shetland channel. July 23rd 1905. Depth 1075 m. Young-fish trawl, 1000 m wire. "Thor" stat. 124 (05). — 1 specimen, about 26 mm wide.

24) — East of Orkney Islands. June 26th 1903. "Michael Sars" stat. 140 (03). — 8 specimens, 25–37 mm wide (25, 30, 30, 33, 33, 33, 35, 37 mm).

25) — Murray Firth. September 4th–5th 1904. "Thor". — 1 specimen, 23 mm wide.

26) — Horns Rev lightvessel, west coast of Jutland. September 23rd 1912. Depth 30 m. Vertical haul, 30–0 m. — 1 specimen, 5 mm wide with about 48 tentacles.

27) — 18 miles south of Oxö lighthouse, Skagerrak. May 28th 1907. Depth 510 m. "Thor" stat. 1074. — 2 specimens. (Plankton Laboratory, Copenhagen).

28) — 12 miles NW. $\frac{3}{4}$ W. of Hirshals lighthouse, Skagerrak. October 9th 1904. Depth 640 m. Young-fish trawl, in intermediate strata. "Thor" stat. 273. — 7 specimens. (Plankton Laboratory, Copenhagen).

The specimens from the "Michael Sars" 1910 and the "Armauer Hansen" are in Bergens Museum, the specimens from the "Thor" stat. 273 and 1074 are in the collection of the Plankton Laboratory in Copenhagen; the other specimens are all in the Zoological Museum of Copenhagen.

The information, given in the literature, on the occurrence of *Laodicea undulata* in the North Atlantic area are rather few and scattered and, moreover, not always reliable, in so far as the species has frequently been confounded with *Cosmetira pilosella* Forbes.

The type-specimens of Forbes and Goodsir were found in the Minch between Scotland and the Hebrides "on a very warm day, when the sea was very calm ...".

"*Laodice cruciata* (*Thaumantias pilosella* Forbes)" has been recorded from St. Andrews Bay by McIntosh (1888) and by Crawford (1891) who states, that it "swarmed throughout August and continued in diminishing numbers till November". After recording the species under the name quoted above, the latter author adds: "with marginal cirri and clubs". This seems to show, that the recorded species is really *Laodicea undulata* and not *Cosmetira pilosella*.

During the investigations of Browne in the Firth of Clyde 1901—02 *Laodicea undulata* was not found.

According to Browne (1900, p. 720) the species has been found several times in the neighbourhood of Valencia Harbour, Ireland. In 1895 it was found in April and July, in 1896 from July to the beginning of September; in 1897 it appeared in May and was fairly common in August and September and again in November, whereafter it disappeared. In 1898 it was found from June to November and was very abundant during July and August. Browne adds: "This species has not often been recorded in British seas". In the paper here quoted Browne calls the species with the name of *L. calcarata*. — It was also at Valencia Harbour that Miss Delap succeeded in rearing *Laodicea* from the Hydroid *Cuspidella costata* Hincks, in June 1906 (Browne 1907, p. 464).

The medusa recorded by Browne 1895 (Report on the Medusæ of the L. M. B. C. District) as "*Laodice cruciata*" belongs to *Cosmetira pilosella* Forbes. But in the same paper (p. 276) is mentioned a specimen of "*Laodice calcarata* L. Agassiz", found at Port Erin on May 5th 1894, a young specimen, 5 mm in diameter "... with about 30 tentacles, and cirri of both shapes" (i. e. filiform cirri and cordyli). "It corresponds to the description given by Agassiz". This medusa has, undoubtedly, been a *Laodicea undulata*, which species may, accordingly, be found at Port Erin.

From Plymouth "*Laodice cruciata*" has been mentioned by Garstang (1894, p. 215), but also in this case the medusa in question has actually been *Cosmetira pilosella* Forbes. Browne (1897 b) gives a list of medusæ, found at Plymouth during September 1893, 1895, and 1897. *Laodicea* is not mentioned in that list. Neither is it recorded in the "Plymouth Marine Invertebrate Fauna" 1904, whereas "*Euchilota pilosella* (Forbes)" is said to be common every summer in the neighbourhood of Plymouth.

Nevertheless, *Laodicea undulata* actually occurs in the British Channel. In the British Museum of Natural History in London I have seen two specimens from Plymouth, and it is recorded from the

Channel (under the name of *Laodice calcarata*) in the International Plankton Catalogues (Catalogue, 1906, 1909, and 1916). We have to be very cautious, it is true, in employing these catalogues, as the identifications of the species have, as a rule, not been made by specialists; in the present case, however, I believe the identification to be correct. In one particular instant I have been able to verify the identification directly, some specimens being present in the type collection of the plankton laboratory in Copenhagen. — During the years from 1903 to 1908 the species has been taken in the Channel almost every year in the month of August, and sometimes also in May; only once it was found in November (1905). It was found in the Bristol Channel in August 1905, 1906, and 1907, and in May 1908. It has also on one occasion been found in the North Sea off the coast of Belgium, viz. in August 1905.

As far as I am aware, *Laodicea undulata* has never been recorded from the east coast of Great Britain south of St. Andrews.

Neither has it been mentioned from Heligoland.

I have worked through a very considerable material of plankton from the Horns Rev light-vessel off the southern part of the west coast of Jutland, but I have only found one single, small specimen of this species.

It seems also to be scarce in the Skagerrak, in so far as it has only been observed twice in that sea; it does not penetrate into the Kattegat.

I have never seen this species recorded from the west coast of Norway, and it seems, on the whole, to be altogether lacking in the Norwegian Sea¹.

Nor is it known to occur off the Atlantic coasts of Europe south of the British Channel.

If we compare the records of the literature with the data derived from the material examined by me, we will gain the following general picture of the horizontal distribution of *Laodicea undulata* in the North-East Atlantic area: The species occurs off the southern coasts of Iceland, is numerous around the Rockall plateau and Scotland; it is also found, though apparently in smaller quantities, off the western coasts of Ireland and England, in the Channel, and in the south-western part of the North Sea. Finally it may be found, occasionally, off the western and northern coasts of Jutland.

All records agree, that this species does not occur in any great distance from the coasts, that the distance from the shore, accordingly, sets a limit to the horizontal distribution. On the other hand, the actual depth is without importance with regard to the occurrence. Some of the specimens here dealt with have been taken in shallow water near the coasts or above the Rockall Bank, others have been found above very deep water, as for instance on the "Thor" stat. 180 (04), where the depth was 2160 m, and several specimens have been found in the Rockall Channel, the Faeroe-Shetland Channel, and the Norwegian Channel.

With regard to the vertical distribution we will find, that the species may occur in very different depths below the surface, it having been found in all strata between the surface and about 800 m below the surface. The results of the cruise of the "Armauer Hansen" in 1913 are particularly instructive with regard to the occurrence of this species. *Laodicea undulata* was lacking on all of the

¹) Hartlaub (1900, p. 172) mentions numerous specimens "der schönen, scheinbar magenlosen *Laodice cruciata*", found during the expedition of the "Olga" at Tromsø (northern Norway) on June 28th 1898. If the identification be correct, we have here an isolated find of high interest.

western stations of this expedition, these stations being situated too far from land; on the other hand, it was found on all of the eastern stations, stat. 1, 2, 4, and 17. But in these localities, all in comparatively short distance from land, the species was found down to the very greatest depths, in which hauls were made, and by no means in small numbers. Particularly interesting is the station 17 in the deep channel between Rockall and Scotland; at this station 9 specimens were taken at the surface, 7 specimens in about 800 m depth, and a number of specimens about 100, 400, and 650 m below the surface. On this locality, accordingly, the species was fairly common in all strata, at least as far down as about 800 m below the surface.

Young specimens are, however, found in the upper water layers exclusively, whereas large and middle-sized individuals may be met with in all depths. In the material at my disposal young individuals are present from the following localities:

- Loc. Nr. 1. "Thor" stat. 45 (08). July 2nd 1908. Surface. — 1 specimen, 12 mm.
 — - 18. — — 11 (08). May 28th 1908. About 40 m depth. — 9 specimens, 8—22 mm.
 — - 20. — — 8 (08). May 27th 1908. About 40 m depth. — 7 specimens, 7—16 mm.
 — - 21. — — 2 (08). May 21st 1908. Surface. — 2 specimens, 6—13 mm.
 — - 26. Horns Rev. September 23rd 1912. 30—0 m. — 1 specimen, 5 mm.

These localities are all situated very near land. It will be observed, moreover, that most of the young specimens have been found at the end of May; one specimen was taken at the beginning of July in Faxebugt on the west coast of Iceland, and one specimen, the smallest which I have seen, was found in September off the west coast of Jutland. — Larger individuals may also be met with early in the year. Thus on May 28th 1908 (Loc. Nr. 15) a specimen, 26 mm wide, was found in about 200 m depth, and the very largest among the specimens observed, 37 mm wide, was found together with 7 other specimens on June 26th 1903 east of the Orkney Islands ("Michael Sars" stat. 140 (03), depth not stated). Most of the large specimens were, however, taken in July and August. This agrees very well with the statements in the literature. According to these the species appears off the British coasts in May, more seldom in April (Valencia Harbour, Browne 1900), is common during the summer months, and disappears in October or November. The material, examined by me, gives no information as to how late in the autumn the species may be met with in the area investigated, because none of the expeditions, the material of which has been at my disposal, has worked in these regions later than in October, most of them only during the summer months.

According to the above statements *Laodicea undulata* is, in the North-East Atlantic area, a summer form, deliberated from the littoral hydroid *Cuspidella* in the spring or the first summer months, reaching its full size in the warm months, and disappearing in the late autumn, after having accomplished its breeding season; probably the planula larvæ attach themselves in the autumn and develop into the hydroid *Cuspidella*, which passes the winter and sends out its medusa generation in the next spring.

Also off the east coast of North America *Laodicea undulata* is a summer form, occurring from June to the beginning of the winter, being most frequent in July and August. — In the Mediterranean, on the other hand, it is found during the winter.

Genus *Ptychogena* A. Agassiz.*Ptychogena lactea* A. Agassiz.

Plate III, figs. 1–6. Textfig. 5.

- Ptychogena lactea* A. Agassiz 1865. North American Aculephæ, p. 137, figs. 220–224.
- — Haeckel 1879. System der Medusen, p. 147.
 - *pinnulata* Haeckel 1879. *ibid.* p. 148.
 - — — 1881. Tiefsee-Medusen der Challenger-Reise, p. 6. Taf. II.
 - *lactea* A. Agassiz 1888. Bull. Mus. Comp. Zool. Harvard Coll. Vol. XV, p. 128.
 - *pinnulata* Levinsen 1892. Meduser etc. fra Grønlands Vestkyst. — Vidensk. Meddel. Naturhist. Foren., 1892, p. 145.
 - — Aurivillius 1896. Plankton der Baffins Bay und Davis' Strait. — Festschr. Wilh. Lilljeborg tillegnad, p. 198.
 - *lactea* Vanhöffen 1897. Fauna und Flora Grönlands. — Drygalski's Grönland-Exped. Bd. II, p. 273.
 - *pinnulata* Grönberg 1898. Hydroid-Medusen des arktischen Gebiets. — Zool. Jahrb. Bd. XI, p. 465.
 - — var. Linko 1904 b. Zool. Studien im Barents-Meere. — Zool. Anz. Bd. XXVIII, p. 217.
 - *lactea* Browne 1907. Revision of the Laodiceidæ. — Ann. Mag. Nat. Hist. Ser. 7. Vol. XX, p. 473.
 - — Mayer 1910. Medusæ of the World, p. 215.
 - — Bigelow 1913. Medusæ ... N. W. Pacific. — Proceed. U. S. Nat. Mus. Vol. 44, p. 28.
 - — Kramp 1913. Medusæ ... "Tjalfe" Exped. — Vidensk. Meddel. Dansk Naturhist. Foren. Bd. 65, p. 268.
 - — 1914. Conspectus Faunæ Groenlandicæ, p. 422.

Description of a full-grown specimen from the south coast of Disco, Greenland, "Tjalfe" Exped. stat. 125.

Diameter (the specimen is preserved in alcohol) about 90 mm, height of the bell about 30 mm. The gelatinous substance is very thick, 10 mm at the apical point; the thickness is almost equal throughout the greater part of the bell; only in the peripheral part, within a short distance from the bell-margin, it is evenly diminishing towards the latter. The stomach is quadrate, attached to the subumbrella along the arms of a perradial cross, so that there are four interradial, triangular pouches between the dorsal wall of the stomach and the subumbrella. The length of the sides of the stomach is 20 mm. The prismatic mouth-tube is short, hardly 10 mm long. The mouth-opening is quadrate; the four perradial corners are dilatated into four quite short lips. The mouth-edge is faintly folded. The perradial cross, mentioned above, along the arms of which the stomach is attached to the subumbrella, is seen on the inner side of the dorsal wall of the stomach as four ciliated grooves; in this specimen the grooves do not meet exactly in the centre (see Plate III, fig. 1); the grooves are centripetal continuations of the dorsal wall of the radial canals. The proximal two-thirds of the 4 radial canals are

funnel-shaped, with a wide opening into the corners of the stomach; the distal one-third of the radial canal is a narrow tube, communicating with the narrow circular vessel. The umbrellular part of the funnel-shaped canal is narrow, and from this part issue a large number of lateral folds or branches, perpendicular to the main canal. The umbrellular walls of these lateral folds are attached to the subumbrella, whence the folds hang as perpendicular lamellæ, the ventral edges being free. Below the narrow, lamelliferous part of the radial canal is the wide, funnel-shaped part, mentioned above, reaching outwards nearly to the outermost (distal) lateral folds, gradually narrowing outwards and terminating in a point. The narrow dorsal part is separated from the wide ventral part by a longitudinal fold on



Fig. 5. *Ptychogena lactea* A. Agassiz. A radial canal with its branches and gonads, seen from the apical side. — From a specimen from Ritenbenk, Greenland.

each side (Plate III, figs. 2 and 3). These two folds continue in a centripetal direction in the dorsal wall of the stomach nearly to the centre along both sides of each of the ciliated grooves (Plate III, fig. 1). Towards the distal end of the funnel-shaped part the folds are gradually tapering; in the distal part of the folding system there is, accordingly, no complete separation between the ventral and the dorsal part of the canal. Thus a differentiation of the gastro-vascular system, similar to that in *Laodicea undulata*, is established in this species. Probably the food is received and dissolved in the wider, ventral part (I have found half-digested copepods therein); the dorsal part only communicates with the ventral part for a short distance near the distal end of the funnel-shaped part. Proximally the dorsal part opens into the dorsal wall of the stomach through a narrow opening, distally it passes into the narrow, tube-shaped part of the radial canal, free of gonads, through which the dissolved nutritive substances, which have been carried from the funnel-shaped part into the dorsal part, are transported further into the circular vessel.

Seen from the aboral side the systems of transversal folds form together four elliptical figures, commencing at a short distance from the corners of the stomach. In the present specimen the length of the elliptical figures is about 24 mm, the largest breadth about 19 mm, the longest (middle) of the lateral branches being about 9 mm long, perpendicularly to the main canal. Within this part of the radial canals there are altogether 20—25 folds on each side of the main canal. Besides these closely set folds there are some short, isolated folds in the lateral walls of the grooves in the dorsal wall of the stomach (see textfig. 5, which has been drawn from another specimen). Each of the lateral branches of the radial canals has the shape of a flat, perpendicularly placed pouch, the dorsal edge of which is attached to the subumbrella along a narrow line, and which opens into the main canal by a perpendicular fissure in the narrow, dorsal part of the canal (Plate III, fig. 4). In the walls of these pouches the gonads are developed. The gonads (Plate III, fig. 5) surround the pouch completely except in the line, by which the latter is attached to the subumbrella. Thus the gonads on the two sides of the pouch communicate around the free (ventral and distal) edges of the pouch. Moreover the gonads of two successive pouches communicate proximally in the perpendicular edge between the openings of the two pouches

into the main canal. Accordingly, each of the four radial canals of the medusa has actually only two gonadial bands, separated in the median line of the canal, but each of these bands is folded in a complicated manner. The free edge of each of the pouches gives rise to a row of papillæ of different length (Plate III, fig. 2). The papillæ are hollow; they are extensions from the lateral branches of the radial canal, and their lumen communicates with the lumen of the latter (Plate III, fig. 5). The papillæ are more closely set in the distal part of each of the lamellæ; in the middle part they are more dispersed, and in the proximal part the edge of the lamella is smooth (Plate III, fig. 2). On the shorter (younger) lamellæ the smooth part is comparatively long, only a few papillæ being present, and these are distally situated; on the longest (oldest) lamellæ the smooth part is quite short; on the quite young lamellæ no papillæ are found, the edge is quite smooth. — The oldest lamellæ are in the middle part of the system; the proximal and the distal lamellæ are the younger. New lamellæ are formed, however, not merely proximally and distally, but also intermediary between the older lamellæ in any spare room in the system. — The side-walls of the lamellæ are, as a rule, not quite plane, but are more or less uneven. We may even, occasionally, find a secondary branch, forming an acute angle with the mother-branch. — In the present specimen the ventral, funnel-shaped part of the radial canals reaches nearly to the distal end of the folded system.

The bell margin carries a large number of tentacles and cordyli. In the present specimen there are 400–500 tentacles. Each of the tentacles has a somewhat compressed bulb, about 2.5 mm long; this bulb is somewhat broader distally than proximally. Its outer (abaxial) edge is convex, the inner (adaxial) edge is straight or faintly concave (Plate III, fig. 6). The distal end of the bulb bends sharply inwards (adaxially) at the point of transition into the thread-like part of the tentacle; very soon the latter bends sharply outwards. The tentacular bulb is hollow; its lumen opens like a funnel into the circular vessel. On the abaxial side of the basal part of the bulb there is a short, conical protuberance (a rudimentary tentacular spur) extending into the gelatinous substance of the ex-umbrella (Plate III, fig. 6). — The cordyli are small; in the present specimen they are about $\frac{1}{6}$ the length of the tentacular bulbs. They alternate fairly regularly with the tentacles, forming a row a little inside the row of tentacles. Each of the cordyli has the shape of a lengthened club, mounted upon a small tubercle closely outside the base of the velum. The cordyli are hollow, but their lumen is very narrow, and in fully developed cordyli it is apparently always separated from the circular vessel, the lumen of the peduncle being quite obliterated. — This specimen seems to represent the fully developed stage of growth, in so far as the tentacular bulbs are all of equal size, and the cordyli alternate with the tentacles and are all situated on small tubercles.

The velum is well developed but weak.

As far as I am aware, this individual is the largest specimen of *Ptychogena lactea* hitherto described. In younger individuals there are a smaller number of lateral folds on the radial canals, and the free edges of the lamellæ carry a smaller number of papillæ; in specimens, less than about 35 mm in diameter, the edges are quite smooth. In younger specimens the funnel-shaped extensions of the corners of the stomach do not reach the distal ends of the gonadial part of the radial canals. The lateral folds, which separate the dorsal part of the radial canal from the ventral part, are not developed in

young individuals. The secondary branching of the lateral branches of the radial canals seems to be a feature of individual variation with no relation to the developmental stage of the specimen.

The smallest specimen, which I have examined, was found near Jakobshavn in Greenland. It is 14 mm in diameter. The state of preservation is not good, especially the stomach is much destroyed. The bell seems to have been comparatively higher than in grown-up individuals; in the present condition of the specimen the height is 8 mm. The length of the folded parts of the radial canals is about 3.5 mm, the largest breadth about 2–2.5 mm. In each of the folding systems 5–6 pairs of lateral folds are present; they confirm the above statement, that new lateral branches are developed not only proximally and distally, but also intermediary; there are no secondary branches. The free margins of

Table III. Synopsis of the specimens of *Ptychogena lactea* examined.

Locality No.	Diameter of specimen	Height of specimen	Sides of the stomach	Distance from the centre to the beginning of the closely-folded part	Length of the closely-folded part	Largest breadth of the closely-folded part	Number of primary folds in the closely-folded part	Length of the distal part of the radial canals, free of gonads	Number of tentacles	Number of cordyli	Remarks
3	mm 90	mm 30	mm 20	mm 11	mm 25	mm 19	40–50	mm 10	400–450	same number as tentacles	Lamellæ with papillæ, a few with secondary branching.
—	70	..	14	11	13–15	13	37–43	13–14	...	..	Largest lamellæ with about 15 papillæ, no secondary branching.
2	68	..	..	..	14–16	12–13	41–49	...	...	...	Lamellæ with as many as 5–6 papillæ; secondary branching.
1	50	..	11	10	10–12	8–9	25–28	...	...	...	Papillæ present; secondary branching. One of the radial canals abnormal, its dimensions not included in the table.
7	40	..	..	..	...	...	...	...	...	...	Secondary branching. Fairly long papillæ.
9	35	20	..	..	8	7.5	about 25	7	...	about equal to number of tentacles	Edges of lamellæ smooth; secondary branching of a few lamellæ. Only one gonadal system measured.
4	14	8	..	..	3.5	2–2.5	10–12	2–3	60–80	more numerous than tentacles	No papillæ; no secondary branching.

the lamellæ are smooth. The length of the distal part of the radial canals, free of gonads, is 2–3 mm. The number of tentacles cannot be stated exactly, but there are about 15–20 tentacles in each quadrant. The cordyli are somewhat more numerous than the tentacles (compare Bigelow, 1913, who states that there is a comparatively larger number of cordyli in young specimens than in older ones). Some of the cordyli are situated on quite small tubercles as in the large individual, but some others are mounted upon large, thick bulbs, very like tentacular bulbs of half size; still others are placed in a manner intermediary between these two extremes.

In order to illustrate the variation and development of the species I have worked up the above synoptic table (Table III) of the specimens examined by me. — Most of the specimens are badly preserved, so that especially the number of tentacles cannot be stated. As will be seen from the synopsis, the shape of the folded part of the radial canals is subject to much variation; it may be

nearly circular in outline, as in the specimen from the Kara Sea (locality No. 9) and the 70 mm wide specimen from the "Tjalfe" stat. 125, or it may be more lengthened, elliptical.

From the "Tjalfe" stat. 171 we have a specimen, 50 mm wide, in which the canal system is abnormally developed. One of the radial canals is bifurcate proximally near its point of issue from the stomach. Each of the two branches has its own system of lateral branches and gonads, and the two systems do not touch each other. The one system is somewhat smaller than the other and diverge somewhat more from the perradial direction. This "secondary" canal has, probably, not reached to the circular vessel; this cannot, however, be stated with certainty. The gonads in the "secondary" system are on the same stage of development as the others, though the lamellæ are somewhat shorter. Another radial canal in the same specimen is bifurcated distally. The folded gonadial part has nearly the normal shape, but the distal end of this part gives rise to two narrow, divergent canals, running to the circular vessel. One of the lateral branches of this gonadial system is twice dichotomically branched.

It has been acknowledged long ago, that the difference between *Ptychogena lactea* Agassiz and *Ptychogena pinnulata* Haeckel depends on development and variation. Haeckel's description is based on two specimens from the Atlantic north of Rockall and a fragment of a specimen, found by the "Challenger" expedition in the neighbourhood of Halifax. The two first mentioned specimens are in the Zoological Museum of Copenhagen; thus I have been able to examine these specimens. Haeckel states that the abaxial side of the tentacular bulbs is concave, whereas the adaxial side is convex, and he gives a drawing in accordance herewith (Haeckel 1881, Plate II, fig. 4). Actually the fact is the contrary (see Plate III, fig. 6). Moreover the cordyli have been drawn too large, especially too thick; they are fairly thin in this specimen. — There is another specimen from the same locality, very badly preserved. As the specimen has hitherto been labelled "*Thaumantias*", and as Haeckel only mentions two specimens from this locality, this specimen has, I think, not been in the hands of Haeckel.

Bigelow's record of *Ptychogena lactea* from the north-western Pacific (1913) is of considerable interest, partly owing to the statement of the occurrence of this species in the Pacific, partly on account of the observation, that the young specimens have a comparatively larger number of cordyli than the full-grown individuals; a specimen with about 50 tentacles had about 160 cordyli.

Among other species, which have been referred to the genus *Ptychogena*, I have already mentioned (p. 13—14) "*Ptychogena erythronon*" Bigelow and "*Ptychogena Hertwigi*" Vanhöffen, which both belong to the genus *Chromatonema*.

The medusa, described by Maas (1893) as *Ptychogena longigona* from the north-eastern Atlantic, has not been found since it was described by Maas, though numerous collections have been made in the same region. Setting aside that ocelli are not mentioned in the description, this reminds one to a considerable degree of *Laodicea undulata*, and I am, in fact, very much inclined to think that this is actually the species described by Maas.

Torrey (1909, p. 13) describes a species from San Diego, California: *Ptychogena californica*. Two young specimens were found, 10 mm in diameter by more than half as high, with about 48 tentacles, 1—5 cordyli between every successive pair of tentacles, gonads with 12—14 folds. This is undoubtedly a *Ptychogena*, but I dare not decide, whether it is a distinct species or only young individuals of *Ptychogena lactea*.

Ptychogena antarctica Browne (1907, more thoroughly described in 1910, p. 29) is distinguished from *Ptychogena lactea* by the fact that the gonadial lateral folds are shorter and not attached to the subumbrella, and by the colour, the base of the tentacles being, according to Browne, provided with red entodermal pigment; according to Vanhöffen (1912), who has refound the species in the material from the German South-Polar expedition, the organs are dark coffee-brown. There is one cordylus between every successive pair of tentacles, and in some of these cordyli Browne found nematocysts (see p. 4).

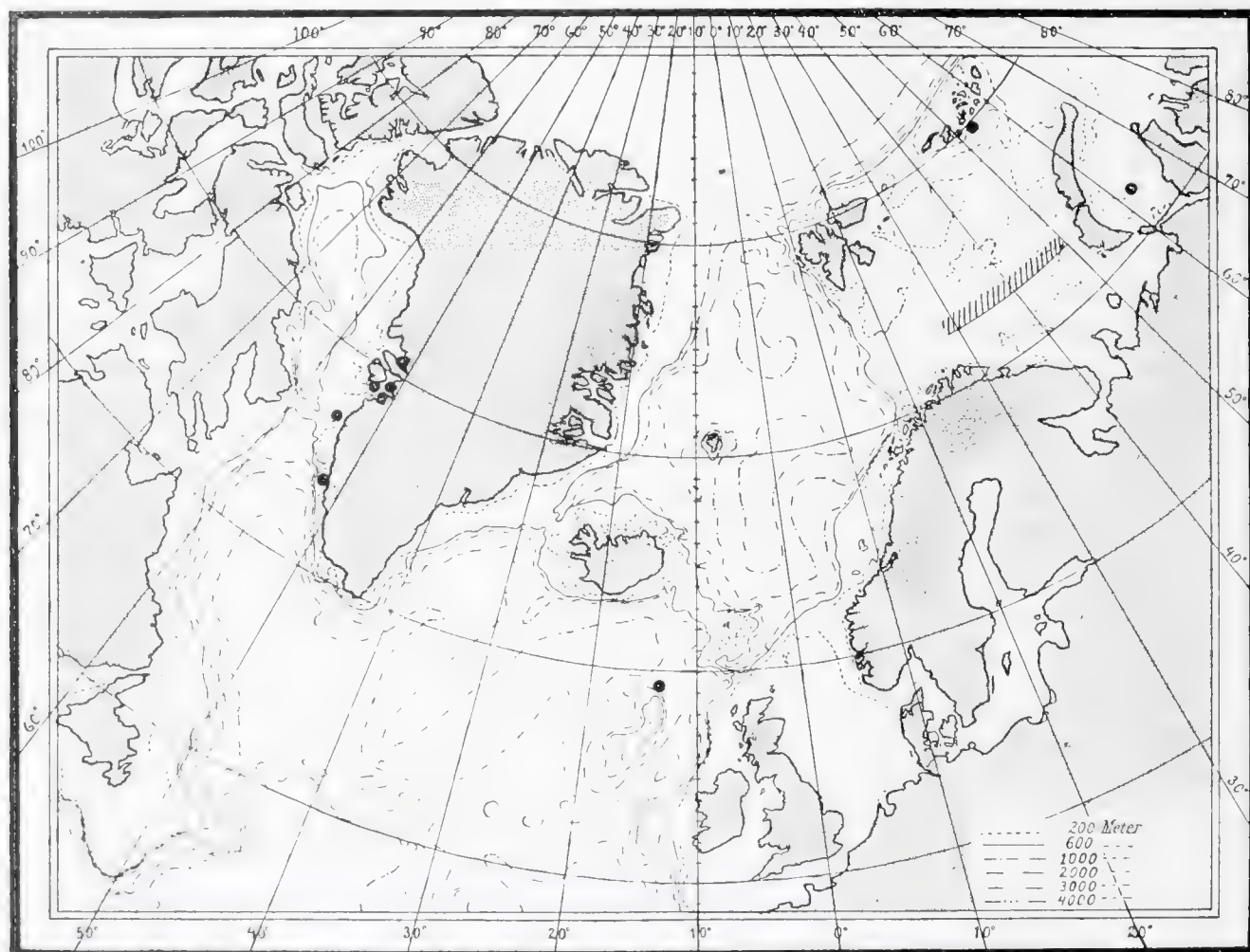


Chart III. Occurrence of *Ptychogena lactea* A. Agassiz in the northern Atlantic and adjacent arctic waters. — The hatching denotes the southern limit of the occurrence in the Barents Sea, according to Linkö.

Vanhöffen (1912, p. 366) describes another species, *Ptychogena aurea*, from four small specimens with about 32 tentacles and gold-yellow gonads with mature sexual products. Cordyli are not present. I am not convinced that this medusa belongs to the genus *Ptychogena*, but I will not deny the possibility.

I have had at my disposal for examination 12 specimens of *Ptychogena lactea* from 9 different localities. In the following list I have also included some non-preserved specimens from Godthaab Fjord, Greenland, found by the "Tjalfe" expedition; in the journal of the expedition they are shortly but not described, so much so that they may be identified with complete security.

Material (see Chart III).

Greenland:

- 1) — Lat. $70^{\circ}41'$ N., Long. $52^{\circ}07'$ W., Umanak Fjord. August 6th 1908. Depth 727 m. Ringtrawl, 800 m wire. "Tjalfe" stat. 171. — 1 specimen, about 50 mm wide.
- 2) — Ritenbenk, Disco Bay. Bergendal. — 1 specimen, about 68 mm wide.
- 3) — Lat. $69^{\circ}17'$ N., Long. $52^{\circ}14'$ W., south coast of Disco. July 16th 1908. Depth 430–440 m. Ringtrawl, 550 m wire. "Tjalfe" stat. 125. — 2 specimens, 70–90 mm wide.
- 4) — Jakobshavn, Disco Bay. Bergendal. — 1 specimen, 14 mm wide.
- 5) — Lat. $66^{\circ}55'$ N., Long. $54^{\circ}37'$ W., 20 miles west of Holstensborg, August 23rd 1908. Depth 66 m. Ringtrawl, 80 m wire. "Tjalfe" stat. 211. — 1 specimen, about 40 mm wide.
- 6) — Godthaab Fjord, Lat. $64^{\circ}11'$ N. August 30th 1908. Ringtrawl, 120–80 m wire. "Tjalfe" stat. 234. Ringtrawl, 30 m wire. "Tjalfe" stat. 235. — Some few specimens, not preserved.
- 7) — Greenland, without further details. "Fylla". — 1 specimen, about 40 mm wide.

Atlantic:

- 8) — Lat. $59^{\circ}07'$ N., Long. $13^{\circ}32'$ W. Moberg. — 3 specimens, two of which are the type specimens of *Ptychogena pinnulata* Haeckel.

Kara Sea:

- 9) — Kara Sea, without further details. "Dijmphna". — 1 specimen, about 35 mm wide.

Polar Sea:

- 10) — Cape Stephens, Franz Joseph Archipelago. H. Fisher. — 1 specimen.

The last-mentioned specimen have I seen in the British Museum of Natural History in London, the others are all in the Zoological Museum of Copenhagen.

Moreover the species has been recorded from the following localities: Near Jakobshavn, Greenland (Vanhöffen 1897, p. 273). — Eastern and western part of the Barents Sea north of Lat. $72^{\circ}30'$ N. (Linko 1905, p. 217). — Near Halifax, Lat. $42^{\circ}08'$ N., Long. $69^{\circ}39'$ W. ("Challenger", Haeckel 1881, p. 6). — Nahant, Massachusetts Bay (A. Agassiz 1865, p. 137). — Bering Sea, Sea of Okhotsk, and off the east coast of Hokkaido, Japan (Bigelow 1913, p. 28). — Moreover Levinsen (1892, p. 3) mentions this species from Iceland from the authority of Faber. In his "Naturgeschichte der Fische Islands" (1829) Faber describes 10 species of medusæ, but I am not able to see, how any of his descriptions could refer to *Ptychogena lactea*.

The places of occurrence off the west coast of Greenland are all near the coast in the cold water. No specimen has been found in that part of the Davis Strait, which is occupied by the comparatively warm Atlantic water.

The data now in hand give us the following general picture of the horizontal distribution of this species:

Ptychogena lactea has its home in the arctic regions, and has probably a circumpolar distribution. It is found off the west coast of Greenland between Lat. $64^{\circ}11'$ and $70^{\circ}41'$ N., further in the Barents Sea, the Kara Sea, and near Franz Joseph Archipelago. Only occasionally it has been found in the Atlantic outside the arctic region, viz. north-west of Scotland¹ and in the Massachusetts Bay. In the Pacific it follows the Kamtschatka Current southwards as far as the northern part of Japan.

¹ If the statement of that locality is correct.

A. Agassiz was of opinion that *Ptychogena lactea* was a deep-water species, and he describes, how it is very rapidly killed by the influence of the light and the higher temperature of the surface water. In the Massachusetts Bay, however, the conditions are so unfavourable for this species, that its occurrence in this area gives no reliable information with regard to its habits under normal conditions. Bigelow (1914 a, p. 98) states as follows: "The occasional occurrence of Arctic pelagic organisms in Massachusetts Bay and the Bay of Fundy, such as the medusa *Ptychogena* and the ctenophore *Mertensia*, neither of which has been able to establish itself in the Gulf, shows that there are occasional indraughts of the St. Lawrence water into the latter. But ... its influence is either sporadic, or seasonal, not constant." A. Agassiz (1888, p. 128) repeats the statement, that *Ptychogena lactea* probably is a deep-sea medusa. On the other hand, Vanhöffen (1897, p. 273) mentions a specimen, found frozen up in the ice in the neighbourhood of Jacobshavn in Greenland, and he remarks (p. 274): "Dieses Vorkommen scheint mir nicht dafür zu sprechen, dass diese Art eine Tiefsee-Meduse ist, wie angenommen wurde". Browne (1907, p. 473) likewise remarks: "There is no trustworthy evidence that it is a deep-sea form".

As far as the material, examined by me, is concerned, the depth in which the specimens have been found is only stated in the case of the material, brought home by the "Tjalfe" expedition. The statements of this expedition show that the species may be found in very different depths off the west coast of Greenland. In Umanak Fjord, which is more than 700 m deep, and the deeper water layers of which have a temperature of about 1° C, *Ptychogena lactea* was found in about 500 m depth. In Disco Bay, the lower strata of which consist, likewise, of cold water, the species was found about 350 m below the surface, at a temperature of 0.9° C. On stat. 211, on the Store Hellefiskebanke, it was found about 50 m below the surface; we have no hydrographical data from the station itself, but judging from observations from neighbouring places, made on the same day, the temperature in the depth in question must have been about 1.5–2° C. Godthaab Fjord is one of the fjords, into which the comparatively warm water-masses of the Davis Strait are not admitted on account of a threshold in the mouth of the fjord. On August 30th 1908, when the temperature of the water in the fjord had been under the influence of the conveyance of a whole summers warmth, the temperature was found to be gradually decreasing from 2.8 at the surface to 1.3 near the bottom (77 m). *Ptychogena lactea* was, in this fjord, found both near the surface (30 m wire) at a temperature of about 2.5, and in 50–70 m depth at about 1.4° C. As the collections of the "Tjalfe" expedition were made with open nets, we may, of course, not be absolutely certain, but that a few animals may have been captured during the hauling up of the net through higher water layers. With regard to the stations 171 (Umanak Fjord) and 125 (Disco Bay) it should be remarked, however, that hauls were also made in higher water layers, and no specimens of *Ptychogena* were taken in these hauls; it is most probable, therefore, that the specimens from these stations have actually been captured in the fairly great depths here stated.

The most important factor determinating the distribution of *Ptychogena lactea* off the west coast of Greenland seems to be the temperature of the water, the species being only found, where the water is cold.

As far as the other biological habits of the species are concerned, nothing positively can be

stated. The specimens from the "Tjalfe" expedition were all found in July and August. With regard to the other material no information of the time of collection are present.

Genus *Staurophora* Brandt.

Staurophora mertensii Brandt.

Plate I, fig. 9; Plate II, figs. 9-10; Plate III, fig. 7.

Staurophora mertensii Brandt 1838. Schirmquallen. — Mém. Acad. Imp. Sci. St. Pétersb. Sér. 6. Tom. 4.
— p. 400. Taf. 24-25.

— *laciniata* L. Agassiz 1849. Contrib. Nat. Hist. of the Acalephæ of North America. —
p. 300. Pl. 7.

Oceania multicirrata M. Sars 1851. Beretning ... Reise i Lofoten og Finmarken. — Nyt Magazin f.
Naturv. Bd. 6. — p. 158.

Staurophora vitrea M. Sars 1863. Geol. og zool. Iagttag. ... Reise i Trondhjems Stift. — Ibid. 1863.
— p. 339.

— *Keithii* Peach 1867.

Staurostoma arctica Haeckel 1879. System der Medusen. — p. 131.

Thaumantias melanops McIntosh 1890. Notes from the St. Andrews Mar. Lab. — Ann. Mag. Nat. Hist.
Ser. 6. Vol. V. — p. 40. Pl. 8.

Staurophora falklandica Browne 1907. Revision of the ... Laodiceidæ. — Ann. Mag. Nat. Hist. Ser. 7.
Vol. XX. — p. 472.

— — Browne 1908. Medusæ, Scottish Nat. Antarct. Exped. — Trans. R. Soc. Edinb.
Vol. XLVI. Part II. — p. 235. Pl. I, figs. 1-7.

— *discoidea* Kishinouye 1910. Some Medusæ of Japanese Waters. — Journ. Coll. Sci. Imp.
Univ. Tokyo. Vol. 27. — p. 29.

The genus *Staurophora* was established and the species *mertensii* was described by Brandt from drawings and notes of Mertens, who had collected this interesting medusa in the northern Pacific during his circumnavigation. L. Agassiz (1849) gave a new description of the genus, based on several specimens from Boston Harbour, North America. Agassiz rightly referred his specimens to the genus *Staurophora* Brandt, but established a new species, *Staurophora laciniata*. The description given by Agassiz is very thorough and clear. He has not, however, observed the cordyli, and none of his specimens were full-grown; later investigations, therefore, have occasioned certain alterations of the description of the species. The species is now so well known that it is unnecessary to give a general description in this place. Maas (1893) and Hartlaub (1897) have demonstrated that it is unreasonable to separate *Staurophora arctica* from the genus *Staurophora* and place it in a proper genus *Staurostoma*; Haeckel (1879) even placed the two genera within two different families at the same time as he observed that they were nearly related.

With regard to the systematical position there can be no doubt but that the nearest relatives of *Staurophora* are the genera *Laodicea* and *Ptychogena*. Mayer (1910), however, separates the genus widely from these genera and places it within the family *Eucopidæ* on account of the presence of

marginal vesicles. These have been described by Linko (1900, p. 4. Taf. II, Fig. 22—25). The marginal vesicles are described as being very small and numerous, one inside each of the tentacles, situated in the ectoderm on the subumbrellular side of the bell inside the circular vessel, just above the supporting lamella of the velum. The structure of the single vesicle could not be examined thoroughly "wegen der schlechten Conservierung" (p. 5). Browne (1908) has tried to find these marginal vesicles, but he found no trace of such organs; it seems reasonable, therefore, to suppose that the vesicles, which Linko found is his, as he states himself, badly preserved material, have simply been due to destruction of the tissues. We must, in any case, wait for new investigations of well-preserved material, before the presence of marginal vesicles in this species can be stated. I myself have sectioned a part of the bell margin of *Staurophora* without finding any vesicles, but, I admit, the material at my disposal is not well suited for such examination.

In the paper quoted above Linko mentions the structure of the ocelli, and he states that within the same specimen we may find every transitional stage from a simple pigment-spot to a cup-shaped eye with a lens.

The most interesting feature in this species is the structure of the mouth. Brandt was of the opinion that the animal had no mouth at all, but that the food was received through the lancet-shaped "arms" in a manner corresponding to the facts in a *Rhizostoma*. Agassiz, on the other hand, calls attention to the eminent extension of the mouth, the corners of the mouth being prolonged along the four arms of the "cross". M. Sars (1863, p. 339) had a similar apprehension. When Haeckel states as a feature characteristic for "*Staurostoma arctica*", that the outer half of the gonadal part is closed, this must undoubtedly be due to a mutual gluing of the folded edges of this part of the mouth; such gluing has been observed by several authors and is also seen in some of the specimens examined by me.

As the corners of the mouth extend as far outwards as the gonads, the latter may in some way be said to have their position on the walls of the "stomach". Hartlaub (1897) takes this as an argument of a near relationship to the *Tiaridæ*. I am more inclined to think that the large extent of the mouth in *Staurophora* is a secondary character, and *Staurophora* is hardly the genus among the *Laodiceidæ* which is nearest related to the *Tiaridæ*. A clear picture of the manner in which the mouth in *Staurophora* has to be understood, has been delivered by Browne (1907, p. 470): "If one were to slit open along the middle the enlarged portions of each radial canal of *Laodicea pulchra*, and imagine the cut margins to be the margins of a mouth, then the position of the mouth, stomach, and gonads would be similar to those of *Staurophora*. I think the mouth of *Staurophora* has arisen by the outgrowth of a central mouth along the enlarged portions of the radial canals of a *Laodicea*-like medusa, and consequently those portions of the radial canals have been converted into a four-rayed stomach. The gonads have not changed their position, but in *Staurophora* they have lengthened slightly and meet in the centre of the cross". I quite agree with this apprehension.

The hydroid generation is unknown; but quite young stages of the medusa have been observed by A. Agassiz (1862, p. 2, and 1865, p. 136) and Hartlaub (1897, p. 487), who have been able to follow the development so far that the species might be identified with certainty. — The first developmental stages of the egg have been observed by Wagner (1885, p. 80—81). — Hargitt (1904, p. 43)

has demonstrated that the development of the eggs takes place in the genital folds, and that the larvæ leave these folds in the shape of actinulæ.

It is beyond all doubt that the species *Staurophora vitrea* Sars, *Staurophora Keithii* Peach, and *Staurostoma arctica* Haeckel are identical with *Staurophora laciniata* Agassiz. Since Bigelow (1913, p. 27) has seen a number of specimens from the same regions, where Mertens found the medusæ described by Brandt as *Staurophora mertensii*, and has had the opportunity of comparing these specimens from the Pacific with specimens from the Atlantic, it may be stated definitely that the species of Brandt and Agassiz are identical. The *Staurophora discoidea* described by Kishinouye (1910) is only separated from *mertensii* "by the more numerous lateral folds of the genital gland", the number of which was 17 in *mertensii*. The description shows that this Japanese medusa in no respect differs from the Atlantic form of *Staurophora*. Thus all *Staurophora* from the northern seas belong to one and the same species, *Staurophora mertensii* Brandt. — In a paper, published in Danish (1914, p. 420), I have stated that *Staurophora falklandica* Browne also belongs to the same species. This fact will be further demonstrated below.

Vanhöffen mentions this species from the Atlantic outside the Bay of Biscay and from the Indian Ocean (1911, p. 219), further from the southern Atlantic between Trinidad and St. Helena and north-east of St. Paul (1912, p. 366). In the last-named paper he also describes a new species, *Staurophora antarctica* from the antarctic Sea. I feel convinced that none of these medusæ belong to the genus *Staurophora*. The specimens were all quite small, and Vanhöffen found that they agreed with Hartlaub's description of the young *Staurophora* from Heligoland. Common for the latter and Vanhöffen's small medusæ is a general likeness to a young *Tiarid*. The medusæ from the Indian Ocean (and the Bay of Biscay) are 1—18 mm wide with 4—64 tentacles. The 3 weeks old specimens described by Hartlaub were 10 mm high and a little broader, though far from 18 mm, and they had already more than 100 tentacles and, besides, a number of cordyli; the latter are not found in Vanhöffen's medusæ. In Hartlaub's specimens no traces of gonads were yet visible; Vanhöffen, on the other hand, mentions visible traces of gonads as grooves in the walls of the stomach in some of the specimens from the Indian Ocean (he does not state how many specimens or what sizes) as well as in the specimen from the southern Atlantic, which was only 5 mm high. Vanhöffen rightly calls attention to the fact, that the gonads being developed as grooves in the walls of the stomach is a feature pointing towards the *Tiaridæ*. But in *Staurophora* the gonads are not placed in grooves, but in lateral extensions developed along the line by which the cross is attached to the subumbrella. Finally, Vanhöffen states that the specimens from the Indian Ocean (and the Bay of Biscay) are provided with ocelli on the outer (abaxial) side of the tentacular bulbs. This statement might possibly be due to a slip of the pen or a misprint; but in the figure of the medusa from the southern Atlantic (1912, Taf. XXV, fig. 3) the ocelli are clearly drawn as being abaxial. Altogether, I feel sure that the medusæ, referred by Vanhöffen (in 1911 as well as in 1912) to *Staurophora laciniata*, are really some kind of young *Tiaridæ*. The same is undoubtedly the fact with regard to "*Staurophora antarctica*". This medusa is 10 mm in diameter and has 8 tentacles; the stomach is deep brown with groove-shaped gonads.

In the following I am going to present some scattered morphological observations, made on the material of *Staurophora mertensii* from the North-Atlantic area, examined by me.

The lower, free margin of the folded mouth-edge is sharply turned outwards as in *Laodicea* and *Ptychogena*.

In full-grown specimens the gonadal folds are more highly developed in the middle part of the cross-arms than in the proximal and distal parts, each cross-arm thus being narrowly lancet-shaped. The primary lateral folds have usually 4—6 secondary folds, more seldom 7 or more. In middle-sized specimens the primary folds have, as a rule, the same number of secondary folds as in full-grown specimens, but as the sexual products are not fully developed, and the walls accordingly are thinner, the secondary folds do not come into contact, but are separated by open spaces. During growth of the animal, new primary folds are formed intermediary between the existing ones. The lateral folds are flattened

Table IV. Dimensions of some specimens of *Staurophora mertensii* from Greenland and Iceland.

Locality number	Diameter of specimens, cm	Largest breadth of cross-arms, mm	Length of narrow part of radial canals, mm	Number of tentacles
3	4 ¹ / ₂	1 ¹ / ₄	3 ¹ / ₂	.
2	about 5	1 ¹ / ₄	4	.
3	5 ¹ / ₂	2	4	...
—	7	...	5	about 1000
5	8	3	5	more than 1200
—	9	4 ¹ / ₂	6	about 1100
—	9	2 ¹ / ₂	5	— 1400
—	10	5	6	— 1400
—	11	7	6	— 1400
—	about 12	8	9—10	— 4400 ¹

¹ calculated.

on their upper (umbrellular) side, but they are only fastened to the subumbrella by narrow branched lines (see Plate II, fig. 9, presenting some lateral folds seen from the aboral side after being carefully loosened from the subumbrella).

The largest breadth of the cross-arms and the length of the distal parts of the radial canals, free of gonads (the "proper" radial canals) have been measured on some specimens from Greenland and Iceland. The results are presented in Table IV, in which I have also given the number of tentacles. The numbers of localities will be found in the list of material below. The specimens are arranged according to the size.

In larger specimens the peripheral part of the exumbrella is provided with numerous deep, sharp, radiating furrows of very different length, though rarely more than 10 mm long; the number of furrows is variable, one being found off every second or fourth of the tentacles (see Plate I, fig. 9).

The tentacles (Plate I, fig. 9; Plate II, fig. 10) are hollow. The basal bulbs are conical; the ectoderm of the bulb is somewhat thickened, particularly on the adaxial side (Plate II, fig. 10). Every

tentacle bears, on its abaxial side, a narrow, pointed, entodermal spur, penetrating into the gelatinous substance close to the exumbrellar side (Plate II, fig. 10). The distal part of the tentacle is, as a rule, spirally coiled. The tentacles are very numerous and, frequently, so densely crowded that, owing to the lack of room, they seem to be situated in somewhat different height on the bell-margin.

In the young medusa the tentacles are developed in a certain regular succession, as demonstrated by A. Agassiz (1863). In older specimens we find tentacles of every size in quite irregular succession. We may find, however, fully developed tentacles and quite young tentacles almost regularly alternating, particularly in very large specimens. When the tentacles are very densely crowded, these young tentacles may be quite thin and delicate, almost like cirri, and apparently situated a little inside the fully developed tentacles. By closer examination, however, we will always find that the small tentacles are not quite alike, but that some of them are a little larger than the others and approach the fully developed tentacles in shape. When there is a little better room, the young tentacles are placed in the same row as the others and have a fairly broad base, clearly indicating that they are real tentacles, not cirri; besides, a spur is very soon developed. Ocelli, on the other hand, are usually not developed until the tentacle has reached a fairly considerable size. The nearly regular alternation of small tentacles without ocelli and large tentacles with ocelli was the feature, on which Browne (1908, p. 235) based the species *Staurophora falklandica*. As exactly the same feature is frequently found in northern specimens of *Staurophora*, and as *Staurophora falklandica* in all other respects has a complete likeness to the northern *Staurophora mertensii*, there can be no doubt as to the identity of the two forms. Browne himself remarks (p. 236): "It is rather a risky point, I admit, on which to base the character of a new species, as there is the probability of the small tentacles developing into full-sized tentacles with ocelli".

As a rule, there is one adaxial ocellus on the base of each of the tentacles with the exception of the quite young ones. Some irregularity may, however, be found. In 4 specimens from North-Iceland ("Thor" stat. 220 (04), Loc. No. 5) the ocelli are arranged in the following manner: 1) Diameter of the specimen 8 cm, ocellus on about every 4th of the tentacles; 2) diameter 9 cm, ocellus on about every 3rd—4th of the tentacles, not seldom two ocelli on one tentacle; 3) diameter 10 cm, ocellus on every 3rd—4th of the tentacles; 4) diameter 11 cm, ocellus on almost every 2nd of the tentacles. Sometimes the pigment of the ocelli may disappear on account of the preservation, and we cannot exclude the possibility that this has happened in the specimens mentioned above, as far as the tentacles now destitute of ocelli are concerned.

In this species the number of cordyli (Plate I, fig. 9; Plate III, fig. 7) is always equal to the number of tentacles, the cordyli regularly alternating with the latter, situated in a row a little inside the row of tentacles. The peduncle is thin and lengthened, the distal part is fairly much swollen. With regard to the question of their transformation into tentacles, see above, p. 5.

The velum is very narrow, 1—2 mm broad.

According to the literature this species may attain a size of 20 cm in diameter. Among the material in hand no specimen is more than about 12 cm wide; this is probably due to the collectors having not, for lack of room, preserved the largest of the specimens found. I remember having seen numerous very large individuals, far more than 12 cm wide, in the waters round Iceland in 1908.

Material (see Chart IV).

Greenland:

- 1) — Egedesminde. Bergendal. — 1 specimen, destructed with osmic acid.
- 2) — Egedesminde. Traustedt. — 1 specimen, about 5 cm wide.
- 3) — Lat. $66^{\circ}06' N.$, Long. $54^{\circ}27' W.$, Davis Strait, off Southern Strømfjord. August 28th 1908. Ringtrawl, 150 m wire. "Tjalfe" stat. 223. — 2 specimens, 4.5 and 5.5 cm wide.

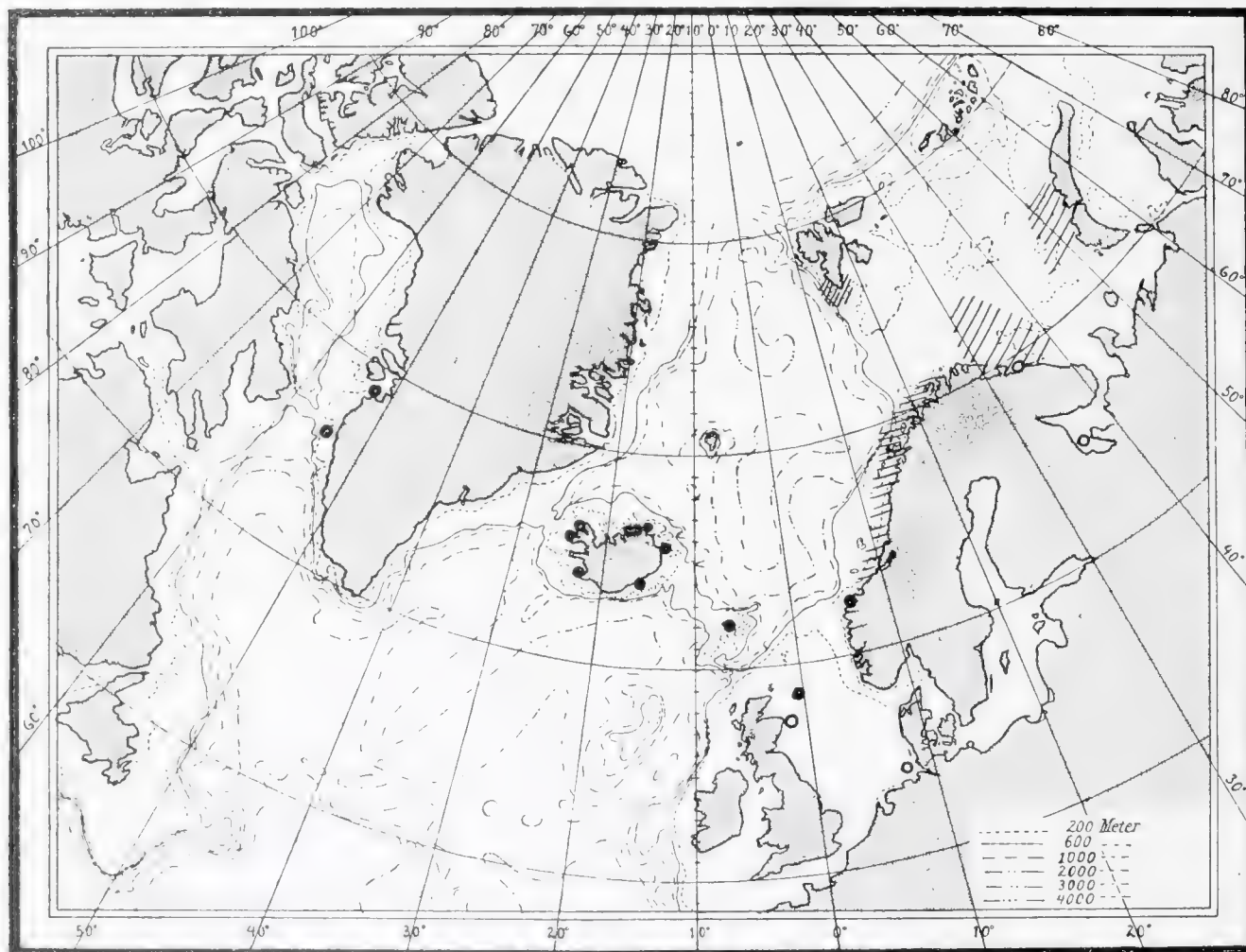


Chart IV. Finds of *Staurophora mertensii* Brandt in the northern Atlantic. ○ and hatching:
Occurrence according to the literature.

- 4) — Lat. $66^{\circ}01' N.$, Long. $54^{\circ}23' W.$, Davis Strait, off Southern Strømfjord. August 28th 1908. Ringtrawl, 150 m wire. "Tjalfe" stat. 225. — A few specimens, not preserved.

Iceland:

- 5) — Lat. $65^{\circ}31.5' N.$, Long. $13^{\circ}32' W.$, East-Iceland. July 29th 1904. Depth 55 m. 60 m wire. "Thor" stat. 220(04). — 5 specimens, diam. 8, 9, 9, 10, 11 cm.
- 6) — Near Grjótnæs, Melrakka. July 26th 1896. "Ingolf" Exp. — 1 specimen, about 7 cm wide.

7) — Axarfjord. August 12th 1903. "Beskytteren", Gemzoe. — 1 specimen, torn, probably about 6 cm wide.

8) — Lat. $66^{\circ}14'$ N., Long. $17^{\circ}28'$ W., Skjalfandifjord. July 21st 1904. "Thor" stat. 208 (04). Pieces of several specimens.

9) — Lat. $66^{\circ}15'$ N., Long. $23^{\circ}30'$ W., off Isafjord. June 15th 1903. "Thor" stat. 134 (03). — One specimen, in the collection of the Plankton Laboratory, Copenhagen.

10) — Dyrefjord. July 14th 1892. Lundbeck. — 1 specimen 7 cm wide.

11) — Lat. $64^{\circ}06'$ N., Long. $23^{\circ}14'$ W., Faxebugt. July 2nd 1908. Depth 98 m. 65 m wire. "Thor" stat. 45 (08). — A piece of the bell-margin with the outer part of a radial canal of a large specimen.

12) — Lat. $63^{\circ}51'$ N., Long. $16^{\circ}29'$ W., Myri Bugt. August 9th 1904. Depth 40 m. "Beskytteren", Gemzoe. — Pieces of a large specimen, which must have been about 12 cm wide. On a 5 cm long piece of the bell margin there are 115 well-developed and as many young and very thin tentacles; the specimen must, accordingly, have had several thousands of tentacles.

Faeroe Islands:

13) — Thorshavn. August 18th 1895. "Ingolf" Exp. — Small pieces of several individuals of different size and stage of development, treated with Flemmings solution.

Norway:

14) — Borgundfjord near Aalesund. June 25th 1902. "Michael Sars", Ad. S. Jensen. — Several torn specimens, not very large.

North Sea:

15) — Lat. $59^{\circ}46'$ N., Long. $0^{\circ}07'$ W., east of the north-point of Scotland. May 7th 1905. 130 m wire. "Thor" stat. 21 (05). — In the collection of the Plankton Laboratory, Copenhagen.

With the exception of the specimens from the localities 4, 9, and 15 the whole of the material here mentioned is in the Zoological Museum of Copenhagen.

Further Distribution:

North Atlantic Area, eastern part:

Spitzbergen (Haeckel 1879, p. 131).

Barents Sea (Linko 1904 a, p. 16 and 1904 b, p. 218). In the eastern (coldest) part of the Barents Sea *Staurophora* is common in the open sea as well as in the neighbourhood of the coast; in the western part it is somewhat scarce in the open sea, and in the summer it is almost never found near the coast. In the unusually *cold* summer of 1899 it was, however, numerous in Kolafjord and in Eka-terin Harbour. Towards the end of the year, on the other hand, it occurs regularly in the neighbourhood of the coast, and it seems then to breed in this region, young medusæ being found here during the first half-part of the year; towards the spring these young medusæ emigrate towards the North.

White Sea (Wagner 1885, p. 80; Birula 1896, p. 16). Wagner found several specimens, 6—12 cm wide, in the Solowetsky Bay in July 1880.

Norway. According to M. Sars (1851, p. 158 and 1863, p. 339) the species is not rare at the coast of Finmarken, where Sars found two specimens, 16 cm wide, in Øxfjord and Havøsund in the

summer of 1849. Sars also found a single specimen near Christiansund. Broch (1905, p. 7) records it, though with some doubt, from Puddefjord at Bergen.

East coast of Scotland. Peterhead, May-June (Peach 1868, p. 97); St. Andrews (Mc Intosh 1890, p. 40).

Heligoland. Young specimens about April 1st, full-grown specimens at the end of May 1895 (Hartlaub 1897, p. 484 ff).

North Atlantic area, western part:

West coast of Greenland. All specimens hitherto known from Greenland (Levinsen 1892, p. 145; Kramp 1913, p. 269 and 1914, p. 420) have been mentioned above.

East coast of North America. New Foundland: Fogo Island, at the surface in July (Bigelow 1909 b, p. 307). — New England: Grand Manan (Stimpson 1854, p. 11; Fewkes 1888 a, p. 233); Eastport (Verrill 1872, p. 6); Massachusetts Bay (L. Agassiz 1849, p. 300 ff; A. Agassiz 1865, p. 136); Woods Hole (Hargitt 1902, p. 553 and 1904, p. 43-44); Fishers Island Sound (Verrill 1875, p. 43); Frye's Island, New Brunswick (Fewkes 1888 a, p. 233). Bigelow, in a series of papers (1914 a, p. 123-124; 1914 b, p. 12; 1914 c, p. 407; 1915, pp. 267, 273, 274, 319, 320), has dealt with the occurrence of this species off the coasts of New England. It appears from his statements that *Staurophora mertensii* is common north of Cape Cod, whereas south of this point it occurs only occasionally, and then only in the spring. In the Gulf of Maine it is "a constant inhabitant", though it occurs particularly in the neighbourhood of the shore; Bigelow states that this is not surprising "because it is undoubtedly neritic" (1914 a, p. 124). Young specimens are found at the end of April or at the beginning of May; thus many very young stages were found in Gloucester Harbour on May 3rd 1913 (op. cit. 1914 c); these young stages probably "have passed through the fixed stage in the near neighborhood". On May 17th of the same year several specimens were found, about 2 inches (5 cm) wide. Grown-up individuals are found in June, July, and August. During the investigations in July and August 1913 (op. cit. 1915) *Staurophora* occurred in the whole of the Gulf of Maine, but not south of Cape Cod. Hargitt (1902 and 1904) has found the species in considerable numbers at Woods Hole, but he remarks: "Its occurrence seems to be somewhat erratic, however, as I have taken specimens but twice within recent years" (1904, p. 44).

The American investigations show that *Staurophora mertensii* is indigenous to the Gulf of Maine and breeds here; further that in the said area its occurrence is not limited to the cold water; south of Cape Cod, on the other hand, it is only an occasional visitor, and in the hot season of the year it is quite absent from that area.

Northern Pacific:

Norfolksound; in the Ocean as far as Unalashka and between Sitka and the Aleutian Islands (Brandt 1835); Dutch Harbor and Prince William Sound, Alaska (Bigelow 1913); Sachalin and northern part of Japan (Kishinouye 1910). In short, it occurs along the southern coast of Alaska, but not off the west coast of North America south of Sitka; further along the coast of Asia as far south as the northern part of Japan.

Falkland Islands:

January 7th 1903 (Browne 1907, p. 473 and 1908, p. 235).

If we compare the statements of the literature with the experiences derived from the material dealt with in the present paper, we will get the following general picture of the distribution and occurrence of *Staurophora mertensii*: In the Atlantic as well as in the Pacific the main distribution of the species is within the arctic region; in both of these oceans, however, the species may penetrate fairly far southwards into boreal regions, though decreasing in frequency. It is exceedingly numerous off the northern and eastern coasts of Iceland, but somewhat scarce off the southern coast, which is washed by the water of the Gulf Stream. In the Barents Sea it mainly keeps itself in the northern and eastern cold parts, whereas it only penetrates to the south-western part, near the Murman coast, in the autumn or in very cold summers. It does not seem to be scarce in the fjords of Finmarken, but only at a few occasions has it been met with at more southerly parts of the Norwegian coast. The occurrence of quite young specimens at Heligoland demonstrates that the species may live and breed in the North Sea, but it is apparently very rare in that area. — Off the Atlantic coast of North America it is indigenous in the Gulf of Maine, but south of Cape Cod it is only met with occasionally and only in the spring months. — In the eastern part of the Pacific its occurrence is limited to the coast of Alaska, in the western part it penetrates as far southwards as extends the influence of the cold Kamtschatka Current.

Everywhere the species is a well-marked coastal-water form. Particularly it is worth mentioning that all finds of young individuals, hitherto known, have been made very near the shore. Young specimens are always found in the spring, April—May, whereas the grown-up specimens are mainly found in August or later (cfr. the statements of the occurrence in the Barents Sea). There can be no doubt, but that *Staurophora* has a neritic, fixed hydroid-generation, which hibernates, and from which the young medusæ are deliberated in the spring.

Of great interest is the bipolar distribution. The medusa described by Browne from the Falkland Islands was found at the beginning of January; thus also in the Antarctic the species is a summer-form.

Family Thaumantiadæ.

Genus *Melicertum* L. Agassiz.

This genus has an interesting but not very joyous history, in so far as it has given rise to much confusion owing to a peculiar want of criticism by some otherwise prominent authors. Hæckel (1879), as the first, has called attention to this confusion and unravelled the history of the genus. But at the same time Hæckel introduced the generic name *Melicertidium* for a species, which was later found to belong to the same genus, which L. Agassiz called *Melicertum*, and thus the question rose, which of these two names ought to be used as the correct one. Browne (1905) and Mayer (1910) have discussed this question and thereby given new accounts of the history of the genus. As the said authors arrive to opposite results with regard to the question of the correct name, I have thought it worth while to deal with the matter once more from a historical point of view, in order to make out my position to that question.

The *Medusa campanula*, as described by Fabricius (Fauna groenlandica, 1780, p. 366), had

4 radial canals and a small number of tentacles, as it appears from the rather short and vague description. — Péron and Lesueur (1809, p. 352) quoted the description of Fabricius and referred the species to the genus *Melicerta*, established by these authors, and written by Oken (1815) *Melicertum*¹. Lamarck (1816, p. 508) called the species with the name of *Dianœa campanula*. — Eschscholtz (1829, p. 105—107) has 4 species of Gen. *Melicertum* Oken, all of which have 4 radial canals: *M. campanula* Fabricius, *M. campanulatum* Chamisso, *M. penicillatum*, and *M. pusillum* Swartz. — *Melicertum campanula* is mentioned again by Oken (1835, p. 226) with reference to the description of Fabricius. — Lesson (1843, p. 313) called it *Campanella Fabricii*, and in Mørch's list of the Acalephs of Greenland (Mørch 1857, p. 95) Fabricii medusa is included as *Campanella campanula*.

In 1835 (p. 24) M. Sars described a medusa, *Oceania octocostata*, with 8 radial canals and numerous (40—60) tentacles, found at the coast of Norway. The next year the same species was figured by Ehrenberg (1836, Taf. VIII, figs. 5—7), who does not seem to have known Sars's description. Ehrenberg gives no description of the animal, but his figures are very good and leave no doubt as to the identity of the species. It is peculiar, therefore, that Ehrenberg, in the explanation of the plates, p. 77, refers this 8-rayed medusa to *Melicertum campanulatum* Eschscholtz, which, as mentioned above, has 4 radial canals. — Some specimens from the north coast of Ireland were identified by Wm. Thompson (1843, p. 281) as *Melicertum campanulatum* Ehrenberg. — Sars's medusa was included in the work of Lesson (1843, p. 312) as *Aequorea octocostata*, and in Forbes's Monograph (1848, p. 30, Plate IV, fig. 1) as *Stomobrachium octocostatum*.

A medusa related to *Oceania octocostata* Sars was found in Massachusetts Bay, North America, by L. Agassiz. It is quite unintelligible, that Agassiz should refer this medusa to the genus *Melicertum* Oken and identify it with *Medusa campanula* Fabricius. With Agassiz the genus *Melicertum* gets an entirely new meaning and is even used (as appears from the note on p. 352) as the type of a family *Melicertidæ*, which is characterised by the possession of 8 radial canals. Agassiz referred four species to his genus *Melicertum*: 1) *M. campanula* Fabricius; 2) *M. pusillum* Eschscholtz (which is incorrectly identified with *Oceania octocostata* Sars, *Melicertum campanulatum* Ehrenberg, *Stomobrachium octostatum* Forbes etc.); 3) *M. campanulatum* Eschscholtz (non Ehrenberg); 4) *M. georgicum* A. Agassiz, shortly described in a footnote on p. 349. — A. Agassiz (1865, p. 130—134) gives a thorough and clear description of *Melicertum campanula* sensu L. Agassiz, but A. Agassiz, like his father, regards the species as identical with *Medusa campanula* Fabricius. Browne (1905, p. 765) rightly remarks: "*Melicertum* has really become a new genus, and with a new type species, *M. campanula* A. Agassiz (non Fabricius)".

Since the forthcoming of the work of Agassiz the American species has always been called by the name of *Melicertum campanula*, and when that name is used for medusæ from the Atlantic coast of North America, any doubt of the identity is excluded. But the mistake of Agassiz has been the cause, why the species for a long time to follow was recorded as occurring at the coast of Green-

¹ In the front-list of contents in Oken's *Lehrbuch der Zoologie, erste Abth.*, *Melicertum* is mentioned as the fourth genus of "Walmmanete", and reference is given to p. 125. Also in the alphabetic register in the rear of the book *Melicertum* is found with reference to p. 125. But if we look at p. 125, we will find that "Walmmanete" only includes three genera. Group D of Gen. *Charybdea* is characterised as follows: "Stiel verlängerte Magen, löst sich in viele Hare auf — *Melicerta*". The name *Melicertum* is not found, nor the specific name *campanula*.

land; Lütken (1875, p. 188) who was not aware of the mistake, included *Melicertum campanula* in his list of the medusæ of Greenland, and from the authority of Lütken it was likewise included in the lists published by Winther (1880, p. 274) and Fewkes (1888b).

Haeckel (1879, p. 136) was the first to see the mistake, and he sharply criticises Agassiz, because he referred the American 8-rayed medusa to *Melicertum campanula* (Fabricius), Eschscholtz, Oken, as also because he referred *Oceania octocostata* Sars to *Melicertum pusillum* Eschscholtz. Haeckel is of opinion, however, that the generic name *Melicertum* Agassiz, *non* Oken and Eschscholtz, ought to be retained for the species *campanula* and *georgicum*, because "Agassiz wirklich die erste gute Beschreibung und Abbildung ... gegeben und die acht Radial-Canäle als Familie-Character hervorgehoben hat".

The European form, on the other hand, is elevated by Haeckel to be the type of a new genus, *Melicertidium*, on account of the presumed presence of "marginale Kolben (oder Cirren)" (op. cit. p. 137). As a matter of fact, Haeckel himself has not seen this medusa, but his meditations are based on the previous descriptions and, obviously, mainly on the figures of Ehrenberg. These figures exhibit a series of short tentacles alternating with the long ones, but on account of the way in which these short tentacles were drawn by Ehrenberg, Haeckel got the apprehension that they were clubs. — After Haeckel (1879) the European form has, mostly, been recorded as *Melicertidium octocostatum*; also Hartlaub (1894, p. 192) uses that name at the same time as he states that the medusa has no marginal bulbs but small tentacles as numerous as the common tentacles, and that this is not a sufficient reason for a generic distinction between the American and the European species.

A review of the generic names, which in the course of time have been applied to these species, will give us the following list: *Oceania*, *Æquorea*, *Stomobrachium*, *Melicertum* and *Melicertidium*. When we want to state, which of those names ought to be used as the correct one, we may at once release the three first, as they are now used for medusæ belonging to quite different groups. Thus remains the choice between the two last-mentioned names.

Browne (1905, pp. 764—767) has discussed this question. After a record of the history of the genus and a demonstration of the identity of *Melicertum* and *Melicertidium* the author states as follows: "After due deliberation, I think it would be the best to retain and amend the genus *Melicertidium*, and to do away with the genus *Melicertum*. To retain the latter genus would only lead to more confusion, as it is clear that *Melicerta* or *Melicertum* of Oken is not the same genus as *Melicertum* of Agassiz. It is really a new genus, with a new type species" (p. 766).

Mayer (1910), on the contrary, prefers the generic name *Melicertum* for the following reason: "... it appears that Ehrenberg, 1837, placed Sars's species in the genus *Melicertum*, and I think it should remain there and be considered a cotype of that genus" (op. cit. p. 207).

Mayer's vindication seems to me to be objectionable, because Ehrenberg's use of the name of *Melicertum* for that medusa was simply due to an erroneous identification. Ehrenberg did not refer his specimens to the species described by Sars (he has, probably, not seen Sars's description), but he identified them erroneously with *Melicertum campanulatum* Eschscholtz.

Something may account for the view of Browne to release the equivocal generic name *Melicertum*, but the use of the name *Melicertidium* seems to me to be precarious, because this genus was

founded by Haeckel owing to a false supposition (the presence of clubs), and because the description, therefore, is erroneous. On the other hand, the characterisation of the genus *Melicertum*, given by Agassiz on the basis of the species *campanula*, is clear and correct. Moreover the genus *Melicertum* Agassiz is older than *Melicertidium* Haeckel. Before we decide to release the name *Melicertum* we must, therefore, examine how far the use of that name may give rise to a continued confusion.

First we must examine the fate of the different species of "*Melicerta*" and "*Melicertum*". In order to illustrate the question I have worked out the adjacent synopsis (Table V) including (first column) all species of the genera *Melicerta* Péron & Lesueur and *Melicertum sensu* Oken and Eschscholtz. In the second column I have recorded by whom and when these generic names have been

Table V. Synopsis of the Species of *Melicerta* Péron & Lesueur and *Melicertum* Oken and Eschscholtz.

Generic name <i>Melicerta</i> or <i>Melicertum</i> used		Name now used
First time	Last time	
Péron & Lesueur 1809:		
<i>Melicerta digitale</i> (O. F. Müll.)	<i>Melicerta digitale</i> Pér. & Les. 1809	<i>Aglantha digitalis</i>
— <i>campanula</i> (Fabr.)	<i>Melicertum campanula</i> Fewkes 1888	? <i>Catablema campanula</i>
— <i>perla</i> (Slabber)	<i>Melicerta perla</i> Blainville 1834	<i>Pelagia perla</i>
— <i>pleurostoma</i> nov.	— <i>pleurotoma</i> Lesson 1843	<i>Turritopsis pleurostoma</i>
— <i>fasciculata</i> nov.	— <i>fasciculata</i> Lesson 1843	<i>Rathkea fasciculata</i>
Eschscholtz 1829:		
<i>Melicertum campanulatum</i> (Chamisso) ¹	<i>Melicertum campanulatum</i> Dujardin 1840	<i>Polyorchis campanulatus</i>
— <i>penicillatum</i> nov.	— <i>penicillatum</i> Lesson 1843	— <i>penicillata</i>
— <i>pusillum</i> (Swartz) ²	— <i>pusillum</i> Lesson 1843	? swimming actinia-larva
Lesson 1843:		
<i>Melicerta morchella</i> nov.	(not mentioned later)	(undetermined)

¹ Used by Ehrenberg 1836 and Thompson 1843 for *M. octocostatum* Sars.

² Used by L. Agassiz 1862 and Kolliker 1864 for *M. octocostatum* Sars.

¹ Used by Ehrenberg 1836 and Thompson 1843 for *M. octocostatum* Sars.

² Used by L. Agassiz 1862 and Kölliker 1864 for *M. octocostatum* Sars.

used for the last time for the species in question. Finally, the last column gives the names, which are now commonly used for these species. *Melicertum pusillum* Eschscholtz and *Melicerta morchella* Lesson have not later been identified.

The application of the name of *Melicertum campanulatum* in Ehrenberg (1836) and of *Melicertum pusillum* in L. Agassiz (1862) is simply due to erroneous identifications, which are, indeed, regrettable enough, but they have done no continuous harm and are of no importance whatever with regard to the question here discussed.

When *campanula* is temporarily excepted, we will see, from the synopsis, that the use of the names *Melicerta* and *Melicertum* in the old meaning (*sensu* Péron & Lesueur, Oken, and Eschscholtz) ceases entirely after the year 1843 (Lesson), in the case of some species even earlier, thus, in any case, long before L. Agassiz used *Melicertum* in a new meaning.

When *Melicertum campanula sensu* Agassiz still as late as in 1888 (Fewkes 1888 b) is recorded

as occurring at the coast of Greenland¹, it is due to Lütken who, not being aware of the mistake of Agassiz, included the species in his list of the medusæ of Greenland, whence it proceeded to the lists of Winther and Fewkes. This is rather annoying, it is true, and may, possibly, still involve misunderstandings; but I am not able to comprehend, how this danger might in any way be removed by the introduction of the name *Melicertidium* in the place of *Melicertum*.

Altogether, it seems to me that the use of the generic name *Melicertum* involves no danger any more for a continuation of the confusion. Since 1843 the names *Melicerta* and *Melicertum sensu* Péron & Lesueur, Oken, Eschscholtz have been applied to no other species than *campanula*. "*Medusa campanula*" Fabricius has to be excluded from the system, as it has not been identified with certainty, and all records of "*Melicertum campanula*" from Greenland have to be omitted. When this is remembered, nobody can have any doubt as to the meaning of the names *Melicertum campanula* Agassiz, *Melicertum georgicum* Agassiz, and *Melicertum octocostatum* (Sars).

When, thus, *Melicertum* Agassiz cannot involve misunderstanding this generic name seems to me to be preferable to *Melicertidium*, because *Melicertum* is older and is correctly defined, whereas the definition of *Melicertidium* is incorrect.

The species of the genus *Melicertum*.

Melicertum proboscifer Maas (1897, p. 19) is undoubtedly a Trachymedusa. — Mayer (1910, p. 209) includes *Melicertella panoto* Haeckel among the species of *Melicertum*, though he indicates the possibility that it may belong to the genus *Melicertissa*. In any case, the presence of ocelli on the base of the tentacles excludes the species from the genus *Melicertum*.

Melicertum georgicum A. Agassiz (L. Agassiz 1862, p. 349; A. Agassiz 1865, p. 135) seems to differ but very slightly from *Melicertum campanula* Agassiz; but since the species was described, no medusa belonging to the genus *Melicertum* has been found in the Pacific; it is impossible, therefore, to state, whether it is identical with the Atlantic-American species. *Melicertum georgicum* is found in the Gulf of Georgia on the west coast of U. S. A.

The two Atlantic species, the European *Melicertum octocostatum* Sars and the American *M. campanula* Agassiz, are undoubtedly nearly related. In the first-mentioned species the height of the bell is about 12 mm, the diameter about as much or a little smaller, and there are fairly constantly 64 longer and 64 shorter tentacles. In *Melicertum campanula* the height and the diameter amount to about 25 mm, and in the full-grown individual the tentacles are all alike; Agassiz and (after him) Mayer state their number to be about 70. There does not seem to be any important difference with regard to the shape of the bell, the manubrium, or the gonads. In *campanula*, it is true, the gonads are said to reach entirely to the circular vessel, whereas in *octocostatum* a small distal part of each of the radial canals is free of gonads; but this feature may, as in other medusæ, be subject to much variation. The tentacles of *octocostatum* are going to be further mentioned below; here I shall only remark that there is no decisive difference between the two series of tentacles. *Melicertum campanula* might very well be considered as a variety which attains a more exuberant development, i. e. when the individual is mature it has a comparatively large size, and all of the tentacles are developed to

¹ My record of *Melicertum campanula* as occurring at Frederikshaab in Greenland (1913, p. 298 and 1914, p. 424) is due to a mistake which I very much regret.

the same size, whereas in *octocostatum* the maturity is accomplished, and the growth comes to a standstill, when the individual is only about 12 mm high, and while half the number of the tentacles have not yet reached full size.

The question, whether *campanula* and *octocostatum* are varieties or independent species can only be solved by direct comparison of specimens of both forms. Particularly it must be examined, whether *campanula* possesses the same peculiar subumbrellular lines of nematocysts, which in *octocostatum* issue from the circular vessel running towards the base of the manubrium. Mayer expressly states that such lines are not yet found in *campanula*. Until these lines have been found, the American species must be regarded as specifically different from the European species.

Melicertum octocostatum (M. Sars).

Plate I, fig. 10; Plate III, fig. 8.

- Oceania octocostata* M. Sars 1835. Beskrivelser og Iagttagelser ... — p. 24. Pl. 4, Fig. 9.
Melicertum campanulatum Ehrenberg 1836. Akalephen des rothen Meeres ... — p. 77. Taf. VIII, Fig. 5—7.
Aequorea octocostata Lesson 1843. Histoire naturelle des Zoophytes. — p. 312.
Stomobrachium octocostatum Forbes 1848. British Naked-eyed Medusæ. — p. 30. Pl. IV, fig. 1.
Melicertum pusillum Agassiz 1862. Contrib. Nat. Hist. U. S. A. Vol. IV. — p. 349.
— — Kölliker 1864. Würtzburger naturwiss. Zeitschr. Bd. 5. — p. 233.
Melicertidium octocostatum Haeckel 1879. System der Medusen. — p. 138.
Melicertum — McIntosh 1890. Ann. Mag. Nat. Hist. Ser. 6. Vol. V. — p. 304.
— *campanula* Linko 1904 b. Zool. Studien im Barents-Meere. — Zool. Anzeiger. Bd. XXVIII. — p. 218.
Melicertidium octocostatum Browne 1905 a. Medusæ ... Firth of Clyde. — Proc. R. Soc. Edinb. Vol. XXV, Part IX. — p. 762.

Melicertum octocostatum is one of the most pretty and elegant among the medusæ of the northern seas. It seems to be fairly common; the number of specimens in the possession of the Zoological Museum is not large, it is true, and the records in the literature are likewise, as a rule, dealing with a comparatively small number of specimens. Only McIntosh states that he has found the species in considerable quantities at St. Andrews. But the journals of the "Thor" frequently mention a "yellow-rayed medusa", which undoubtedly means this species, as being found in considerable numbers, among others at the coasts of Iceland. In the following record of the distribution of the species I have not, however, thought it advisable to pay regard to these records of the journals, but I restrict myself exclusively to mentioning the preserved material in my possession and the statements of the literature.

Description: The umbrella is bell-shaped. The gelatinous substance is fairly much thickened in the apical part of the bell, while the side-walls are thin-walled. The largest diameter is a little above the margin of the bell.

The stomach is, when contracted, longitudinally folded in 8 folds, and there are apparently 8 short, recurved mouth-lips. Sars (1835), however, states that "When these 8 folds are extended, which

sometimes happens, the opening of the stomach or the mouth becomes fairly large and circular. Besides the margin is entire . . ."¹ The base of the stomach is broad, octangular, and the whole dorsal side is entirely attached to the subumbrella; there are, accordingly, no "grooves" or "centripetal continuations of the radial canals". The 8 radial canals open in the upper part of the sides of the stomach through perpendicular slit-shaped openings (Plate I, fig. 10). On each side of these openings there is a perpendicular fold. Probably the opening may be closed by means of these two folds, the lumen of the radial canal thus being separated from that of the stomach.

The radial canals are attached to the subumbrella along straight lines, but the lateral walls of the canal are, for the greater part of their length, folded and sinuous and contain the gonads. The folded gonads commence at some distance (about one-fourth of the length of the radial canal) from the stomach; they are most highly developed towards the distal end; distally about 1 mm of the radial canal is free of gonads. It is interesting that even fully developed gonads do not cover the whole of the lateral wall of the radial canal in the dorso-ventral direction; they commence at a fairly considerable distance from the subumbrella, so that on each side of the radial canal nearest to the subumbrella there is a stripe free of gonads; ventrally, on the other hand, there is only a very narrow streak which separates the gonads of the two sides. This structure is demonstrated in Plate III, fig. 8, which represents a transversal section through a radial canal with female gonads.

The subumbrellular lines of nematocysts are clearly visible in several of the specimens examined. There are usually 5–7 of these lines in each octant. They issue from the circular vessel and run in a centripetal direction towards the base of the manubrium; a few of the lines may reach almost to the base of the stomach. It is, probably, those stripes, which were described by Wright (1867, p. 42. Pl. I, fig. 1) as "a supplementary canal system"; Wright states, however, that they issue from the sides of the stomach, running to the circular vessel, forming anastomoses with one another.

The tentacles are hollow; their basal part is laterally compressed. With regard to their number and development I shall make the following remarks: In full-grown specimens there are about 64 large tentacles and about as many small ones; the latter are directed somewhat inwards (adaxially). The large and small tentacles do not, however, alternate in an absolutely regular manner; now and again between two successive fully developed tentacles we may find one quite small tentacle and one of intermediate size, or two fully developed tentacles are placed immediately beside each other, no small tentacle or tentacular bud being found between them. In younger specimens we find tentacles in all stages of development, but as a rule they may be divided into three groups according to size. Specimens 6–7 mm wide have, as a rule, got all of their 128 tentacles, viz. 32 fully developed, a similar number of somewhat smaller, and about 64 quite small tentacles. In an individual, about 7 mm wide, from the north-east coast of Iceland ("Thor" stat. 203 (04)) the mode of development of the tentacles is clearly visible from their size. Beside the 8 perradial tentacles there are, in each octant, 3 long tentacles, which however seem to be a little smaller than the perradial ones; further 4 tentacles, somewhat smaller and still somewhat inwardly directed; and finally 8 quite small tentacles. It is seldom, however, that the grouping in three groups of size is so distinct and regular; as a matter of

¹ "Naar disse 8 Folder udbredtes, som undertiden skeer, bliver Mavens Aabning eller Munden temmelig stor og cirkelrund. Iøvrigt er den heelrandet . . ."

fact, in such younger specimens we usually find every possible transitional stage of development between the smallest and the fully developed tentacles.

Material (see Chart V):

North-East Iceland:

1) — Lat. $66^{\circ}10' N$, Long. $14^{\circ}29' W$, near Langenæs. August 13th 1904. Surface. "Thor" stat. 253 (04). — Specimens in the collection of the Plankton Laboratory, Copenhagen.

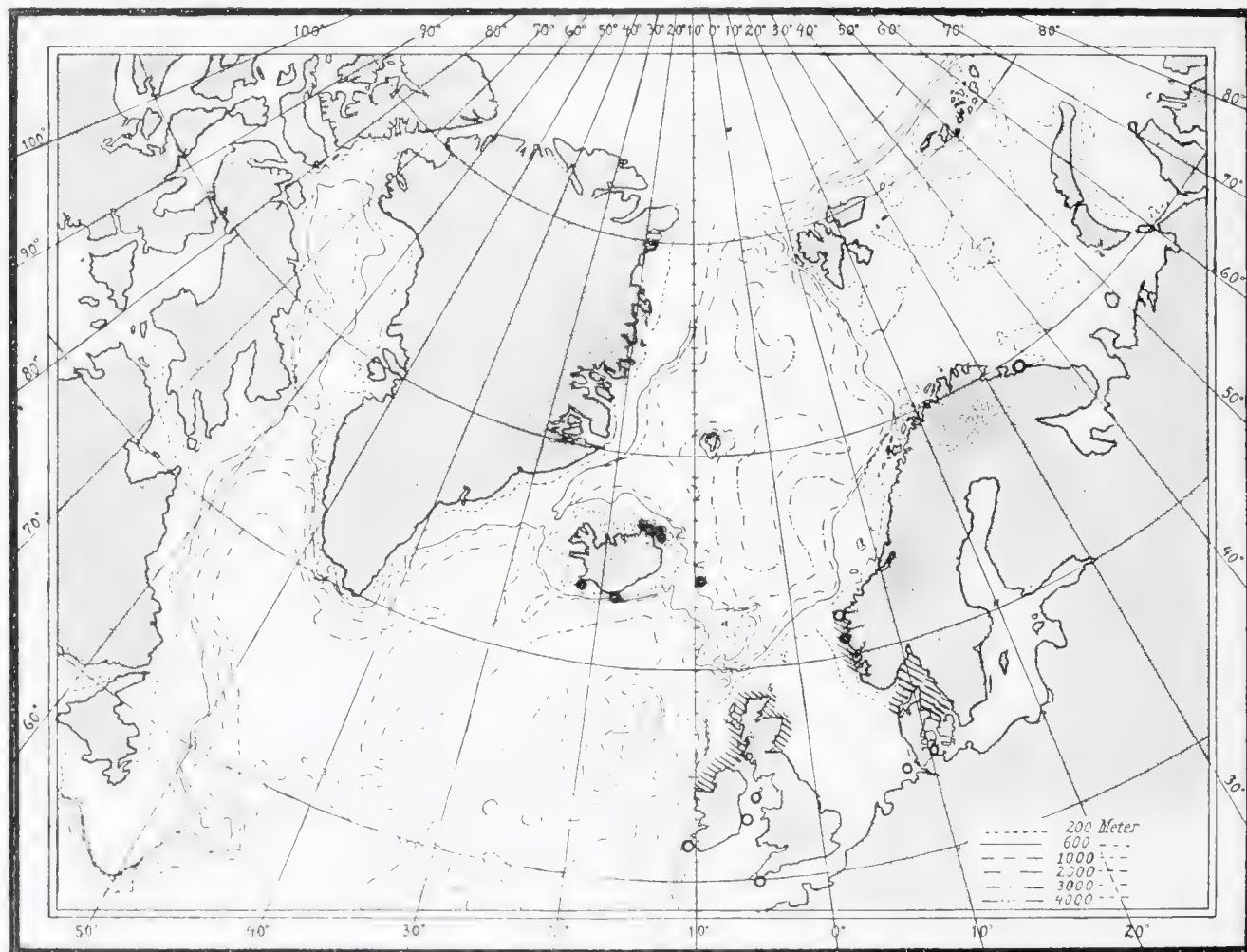


Chart V. Occurrence of *Melicertum octocostatum* M. Sars. O Occurrence according to the literature.
In the hatched regions the species is commonly occurring

2) — Lat. $66^{\circ}17' N$, Long. $14^{\circ}27' W$, near Langenæs. July 20th 1904. Depth 77 m. Young-fish trawl, 80 m wire. "Thor" stat. 203 (04). — 1 specimen, height 6 mm, diameter 7 mm.

3) — Lat. $66^{\circ}25' N$, Long. $14^{\circ}51' W$, near Langenæs. August 14th 1904. 70 m wire. "Thor" stat. 257 (04). — Specimens in the collection of the Plankton Laboratory, Copenhagen.

4) — Lat. $66^{\circ}46.5' N$, Long. $14^{\circ}57' W$. August 20th 1904. Depth 102 m. "Beskytteren", Gemzoe. — 1 specimen, height 11 mm, the apical jelly 3 mm.

5) — North of Tistil Fjord. August 30th 1904. Depth 28 m. "Beskytteren", Gemzoe. — 1 specimen, fairly large.

6) — Lat. 66°38' N., Long. 16°18' W., off Melrakka. August 15th 1904. Depth 102 m. "Thor" stat. 258 (04). — 5 specimens, diam. 6—11 mm.

South Iceland:

7) — 9 miles off Krisuvikrberg. July 11th 1903. "Thor" stat. 162 (03). — Specimens in the collection of the Plankton Laboratory, Copenhagen.

8) — Portland Head. July 18th 1903. "Thor" stat. 176 (03). — Specimens in the collection of the Plankton Laboratory, Copenhagen.

Between East Iceland and the Faeroe Islands:

9) — Lat. 64°05' N., Long. 9°38' W. August 6th 1904. 80 m wire. — Specimens in the collection of the Plankton Laboratory, Copenhagen.

Norway:

10) — Borfjorden, near Bergen. August 8th 1903. "Michael Sars". — 1 specimen, 5 mm wide.

11) — Bergen. July 6th 1911. Th. Mortensen. — 2 specimens, height 5—8 mm, diameter 6—7 mm.

The specimens from the localities 2, 4, 5, 6, 10, and 11 are in the Zoological Museum of Copenhagen.

Further Distribution:

According to Browne (1900, p. 696) *Melicertum octocostatum* is common at the coasts of Scotland but rare in the southern part of the British area. As to the east coast of Scotland it has been found in Cromarty Firth (Romanes 1876 a, p. 526), at St. Andrews (McIntosh 1890, p. 304; Crawford 1891, p. 296), and in Firth of Forth (Wright 1867, p. 42). At the west coast of Scotland it seems to be common in Firth of Clyde and in the fjords and sounds of the surrounding area (Forbes 1848, Kölliker 1864, Browne 1900 and 1905 a).

It is still common in the gulfs on the north coast of Ireland (Thompson 1843 and 1856, Forbes 1848), but only occasionally it drifts further southwards. A few specimens are found at Dublin (Greene 1857), Port Erin (Browne 1895) and Valencia Harbour (Browne 1900 and 1905 a, Delap 1905).

In the British Channel it has only been taken once, *viz.* at Falmouth (Cocks 1849), "abundant in the summer".

The northernmost locality, where the species has been found, is the Murman coast; here it has been taken at three occasions (Linko 1904 b). — At the Norwegian coast it was taken in great numbers at the Florø by M. Sars (1835). It is also recorded from the surroundings of Bergen (Broch 1905) and from Drøbak in Kristiania Fjord (Ehrenberg 1836).

In the Danish waters it has been found at several localities in the Skagerrak and the Kattegat, and Möbius (1873) records it from the harbour of Kiel.

The literature as well as the data derived from the present material demonstrate that *Melicertum octocostatum* is a distinctly neritic species (the American *Melicertum campanula* is likewise "strictly confined to the coast water" (Bigelow 1914 a, p. 125)). The only locality in some considerable distance from the coast is that which is mentioned in the above list as No. 9.

The depth in which the individuals have been captured is only stated in very few cases. Some of the specimens from Iceland are fished with 70—80 m wire out; on "Thor" stat. 259 (04) three hauls were made with the young-fish trawl; the journal records as follows: 20 m wire: "yellow-rayed medusa"; 35 m wire: about 20 do.; 70 m wire: about 20 do. The depth of the bottom was 102 m, and *Melicertum* has been evenly numerous at least in the upper fifty meters. Undoubtedly it does not penetrate down into any great depth; it may be met with, on the other hand, close to the surface.

The horizontal distribution, it will be seen, is rather narrowly limited. The species has never been found in high-arctic regions, and it does not, on the other hand, penetrate very far southwards. It is indigenous at the northern coasts of the British Isles, but only occasionally it is carried towards the Channel. It is very noticeable that most of the Icelandic localities are crowded around Cape Langenæs, the north-eastern point of Iceland. This seems to be more than a casuality and it may possibly be explained by the fact, that the Polar Current strikes the coast of Iceland at this point and puts a stop to the effects of the Irminger Current (that branch of the Gulf Stream which runs northwards along the west coast and eastwards along the north coast of Iceland). It is hardly possible that the numerous individuals of *Melicertum*, found around Langenæs in July and August 1904, may have been carried to the Icelandic coast by the Polar Current; most probably they have been hatched at the west or north coast of Iceland and carried eastwards by the Irminger Current as far as Langenæs, where they have come to a stop, because the cold water of the Polar Current barred the passage. At the Norwegian coast the species is numerous off the part between Stavanger and Stat. It has frequently been found in the Danish waters, but never in any large number, so that this area is possibly beyond the proper area of distribution of the species. The fact is, probably, that the polyp generation does not live at the Danish coasts and the southern parts of the British coasts, but that the medusa is usually carried to these regions in the summer. In order to elucidate this question more thoroughly we shall have to look at the seasons, in which the species has been found on the various localities.

All the Icelandic collections have been made during the summer months; we have no information from the other seasons of the year. The finds from the north-east point are from the time between July 20th and August 30th.

The specimens from West-Norway, mentioned by Broch, as well as the specimens from Bergen, recorded in the present paper, have all been taken in July and August. More interesting is the statement of Sars, that the species occurs at the Florø from the early spring to September.

We possess several and detailed records of the occurrence at the British Isles, but it is not very easy to get a reliable apprehension of the occurrence in that area. Most statements agree that the species appears in the Scottish fjords in the month of May and is numerous during the summer months. Browne (1905) states that it occurred in the Firth of Clyde from May 20th to October 11th 1902, grown-up specimens in May, grown-up as well as young specimens in July; besides many grown-up individuals were found at Arran in August 1897. According to McIntosh (1890), on the other hand, it appeared at St. Andrews in August; it was numerous in October but not yet mature; large specimens were found in December; he also found it at St. Andrews in January, and Crawford (1891) likewise found a mature specimen in January at the same locality. All records being kept together, it seems

to me the most probable that the breeding of the medusa takes place at the end of the autumn or in the winter, that the unknown polyp-generation lives during the later winter months and deliberates the medusæ in the first spring-months; the medusæ then appear in the fjords in May or later and grow to maturity in the course of the summer and autumn.

The finds at Port Erin and Valencia Harbour were made on May 26th and 27th and on June 2nd and July 19th (altogether 4 finds, according to Browne 1900 and Delap 1905). There are two possible explanations of these finds: The few specimens, mentioned by the said authors, may have been carried southwards after their deliberation from the polyps; but as the dates of the finds are mostly antecedent of the season, at which the species is most numerous in the northernmore regions, there is also the possibility that they have been deliberated in the neighbourhood of the finding-places from hydroids originating from medusæ, which were carried down there in the preceding winter or autumn, that the hydroid, accordingly, is able to live here in the winter, as also the medusæ may pass the spring but die away towards the hot summer time. Both explanations give the result, that the whole cyclus of development cannot be traversed on the spot, but new specimens must be imported every year. From the data now in hand it is impossible to state with certainty, which of the two possibilities is the correct one. It seems to me, however, that the first explanation is the more probable, as it appears that the species is able to live in the Danish waters in the warmest months of the year.

As far as the Danish waters are concerned, the facts lie more clearly. All finds from the Kattegat have been made between medio June and medio August. According to Möbius it occurs at Kiel in October—November. In the eastern part of the Skagerrak it has been found in November (International Plankton Catalogues). Nothing indicates that the polyp generation should live in the Danish waters. The medusæ found here have undoubtedly been imported by the current. They are able to keep themselves alive in our seas during the hot summer months, but it is very improbable that they ever breed here. More detailed records of the occurrence of *Melicertum octocostatum* in the Danish waters will appear in a future paper.

Melicertum campanula L. Agassiz.

As mentioned above this species is possibly identical with *Melicertum octocostatum* Sars. It occurs at the eastern coasts of North America, being common from Eastport to Cape Cod. It has been mentioned from that area by the following authors: L. Agassiz (1862, p. 349), A. Agassiz (1865, p. 130—134), Verrill (1871, p. 6), Fewkes (1888 a, p. 233), Mayer (1910, p. 207), Bigelow (1914 a, p. 125; 1914 b, p. 11; 1915, p. 316, 319, 320). South of Cape Cod it has only been taken once, viz at Woods Hole (Nutting 1901, p. 382).

According to these authors the species appears at the coasts of New England in May and disappears in July or August. Young individuals are found in the spring.

Bigelow characterises it as boreal-neritic; it has never been found more than 10 miles from the shore.

Genus *Dipleurosoma* Boeck.

Dipleurosoma typicum Boeck.

Mayer 1910, Medusæ of the World. p. 224.

Bell usually flatter than a hemisphere and about 15 mm in diameter. Stomach flat, with an irregular outline; there are four lips. The number of radial canals arising from the periphery of the stomach ranges from 5 to 18; they branch in an

irregular manner, all branches communicating with the circular vessel. The gonads are developed upon a number of the radial canals adjacent to the stomach. More than 100 marginal tentacles, each carrying an ocellus on the inner side of the bulbous base. Velum is well developed.

North-Atlantic coasts of Europe and off Newfoundland.

Family Mitrocomidæ Torrey.

Leptomedusæ with open marginal vesicles.

The first author who has paid attention to the systematical importance of the open marginal vesicles is E. Metschnikoff (1886 a, p. 5; 1886 b, pp. 81 ff.). He separated *Halopsis ocellata* Agassiz from the *Æquoridæ* (among which it had been placed by A. Agassiz and Haeckel) and the genera *Tiaropsis* and *Mitrocoma* from the *Eucopidæ*, and united the said forms into a family *Lafoëidæ*. Metschnikoff had demonstrated that the planulæ of "*Laodice cruciata*" as well as of *Mitrocoma annæ* developed into hydroids, exactly resembling *Cuspidella* Hincks. At the first sight this seems rather peculiar; but Metschnikoff calls attention to the fact that *Laodice* is an Ocellate, *Mitrocoma* a Vesiculate, while *Tiaropsis* forms the connecting link between the two. If we regard *Tiaropsis* as a more primitive form of the *Lafoëidæ*, the *Thaumantidæ* (to which belongs *Laodice*) and the medusæ with open marginal vesicles have to be regarded as two diverging branches of the same group.

Maas (1893, p. 60) amends the family *Lafoëidæ* sensu Metschnikoff, including *Tiaropsis*, *Mitrocoma*, *Phialis* (i. e. *Halopsis cruciata* Agassiz), *Halopsis ocellata*, and perhaps *Euchilota* and *Mitrocomella*.

Torrey (1909, p. 16) proposes the name of *Mitrocomidæ* for this family, because the medusæ in question bear no relation to the hydroid-family *Lafoëidæ*. The name *Mitrocomidæ* is also used by Browne (1910, p. 32), who gives a revision of the genera of the group and announces a critical revision of the species. Browne hesitates to refer *Halopsis* to this family, until its marginal vesicles have been thoroughly examined. Later Bigelow (1914 a, p. 102) has demonstrated that *Halopsis ocellata* has open sensory pits of the type of the *Mitrocomidæ*. Bigelow (1913) also unites the leptomedusæ with open marginal vesicles into a family *Mitrocomidæ*, whereas Mayer (1910) does not apply more systematical importance to the open marginal vesicles than that of a generic character. In the quoted paper (1913) Bigelow demonstrates that "*Laodice cellularia*" A. Agassiz has open marginal vesicles and accordingly belongs to the *Mitrocomidæ*. As this species has many marginal vesicles but is destitute of cirri, it makes a proper genus, *Halistaura* nov. — As generic characters Browne uses the presence or absence of cirri or ocelli together with the number of marginal vesicles. Thus the genus *Mitrocomella* is only separated from *Mitrocoma* by the number of vesicles being constantly 16, whereas in the full-grown *Mitrocoma* the number exceeds 16. This does not seem to me to be sufficient reason for a distinction of genera. The species *polydiademata* (the only species of *Mitrocomella* hitherto known) does not differ from the species of the genus *Mitrocoma* in any important characters, and I prefer, therefore, to refer it to that genus, following Mayer (1910, p. 290).

A synopsis of the genera of the family *Mitrocomidæ* will now look as represented in Table VI:

Table VI. Synopsis of the Genera of *Mitrocomidæ* Torrey.

Genera	Number of radial canals	Cirri	Ocelli	Number of marginal vesicles
<i>Cosmetirella</i> Browne.....	4	÷	÷	8
<i>Cosmetira</i> (Forbes) Hartlaub.....	4	+	+	8
<i>Tiaropsis</i> Romanes ..	4	÷	÷	8
<i>Mitrocoma</i> Haeckel	4	+	÷	16 or more
<i>Halistaura</i> Bigelow	4	÷	÷	about 12-21
<i>Halopsis</i> Agassiz	12-16 or more	+	÷	numerous

+ = present; ÷ = absent.

Strictly spoken, the "cirri" of *Cosmetira* should not be called with that name, as they are comparatively short and rigid and may not be coiled up spirally; they ought, as stated by Hartlaub (1905), be designated as dwarf-tentacles.

Genus *Mitrocoma* Haeckel.

Mitrocoma polydiademata (Romanes).

- Tiaropsis polydiademata* Romanes 1876 a, Prelim. Observations on the Locomotor System of Medusæ. — Philos. Trans. Roy. Soc. London. Vol. 166. — p. 274.
- Tiarops* — Romanes 1876 b, Some New Species, Varieties and Monstrous Forms of Medusæ. — Journ. Linn. Soc. London. Vol. XII. — p. 525.
- Tiaropsis* — Romanes 1877, do. (plates). — ibid. Vol. XIII. — p. 194; Pl. XV, fig. 3.
- Mitrocomella polydiadema* Haeckel 1879, System der Medusen. — p. 185.
- — Browne 1895, Medusæ, L. M. B. C. District. — Proc. Trans. Liverpool Biol. Soc. Vol. IX. — p. 279.
- *fulva* Browne 1903, Medusæ from Norway and Spitzbergen. — Bergens Museums Aarbog 1903. — p. 17. Pl. I, fig. 3; Pl. III, figs. 1, 3.
- *polydiademata* Browne 1905 a, Medusæ, Firth of Clyde. — Proc. R. Soc. Edinb. — p. 767.
- *polydiadema* Browne 1910, National Antarctic Exped., Nat. Hist. Vol. V. — p. 33.
- Mitrocoma polydiademata* Mayer 1910, Medusæ of the World. — p. 290.
- Mitrocomella* — Bedot 1912, Histoire des Hydroïdes, 4^{me} période. — p. 414.

Umbrella nearly hemispherical, 12-22 mm wide. Stomach small with a cross-shaped base and 4 short, folded lips. Gonads linear or somewhat sinuous, extending along the outer three-fourth of the 4 radial canals. About 48 long tentacles with conical basal bulbs; numerous long marginal cirri; 16 open marginal vesicles; no ocelli. Manubrium, gonads, and tentacular bulbs red or yellowish-brown. — Hydroid unknown.

Haeckel introduced the spelling *polydiadema*, but Romanes called it *polydiademata* in all of the four papers in which he mentioned the species.

Romanes mentions this species for the first time in his preparatory work on the locomotor system of the medusæ (1876 a) and describes it in the other paper of the same year (1876 b). Romanes

describes the 16 "diadems", each containing 30 "pearly nodules"; he further mentions the high illuminating power of the animal. The description is, however, rather short and not very exhaustive.

In 1903 Browne described a species, *Mitrocomella fulva* from Bergen and Plymouth, but in 1905 he states that it is identical with *polydiademata*, of which species he gives, at the same time, a new and more thorough description based on specimens from the Firth of Clyde (1905, p. 767).

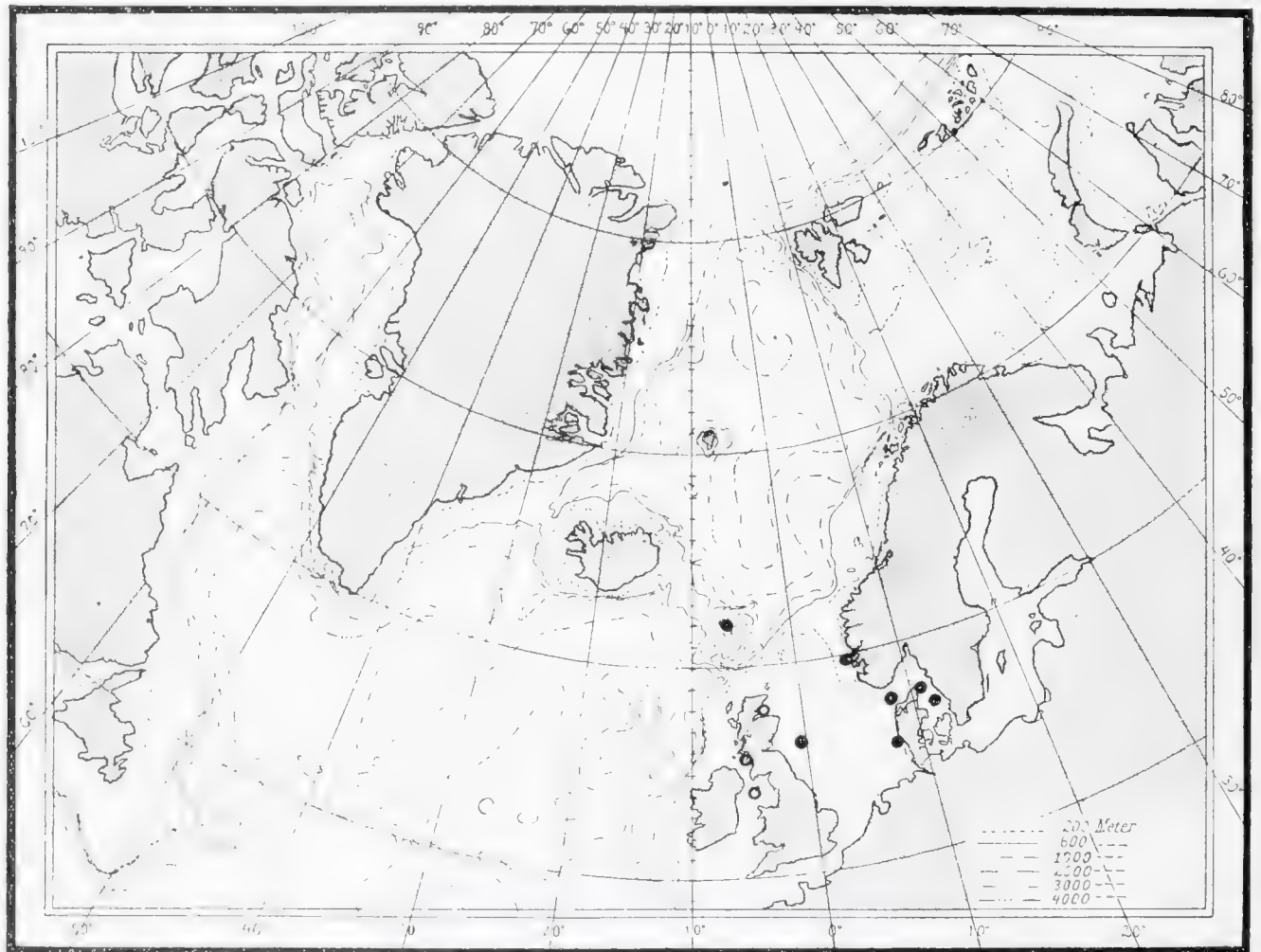


Chart VI. Finds of *Mitrocoma polydiademata* (Romanes). O Occurrence according to the literature.

Material (see Chart VI):

- 1) — Off Trangisvaag, Faeroe Islands. May 14th 1904. Young-fish trawl at the surface. "Thor" stat. 80 (04). — 1 specimen, about 13 mm wide. In the collection of the Plankton Laboratory, Copenhagen.
- 2) — Lat. 59°54' N., Long. 4°34' E., near the coast of Norway south of Bergen. May 8th 1905. Young-fish trawl, 65 m wire. "Thor" stat. 24 (05). — 1 specimen, about 22 mm wide.
- 3) — Lat. 56°08' N., Long. 0°15' W., about 90 miles off the mouth of Firth of Forth. May 4th 1905. Young-fish trawl, 80 m wire. "Thor" stat. 16 (05). — 4 specimens, 10—14 mm wide. In the collection of the Plankton Laboratory, Copenhagen.

The specimen from the Faeroe Islands (Loc. 1) is a female, the gonads of which are very much sinuous but not mature. From Loc. 3 there are one female and three males. The specimen from Loc. 2 is a male, the gonads of which are three-fourth the length of the radial canals; the number of tentacles in this specimen cannot be stated exactly, but it exceeds 40. In the males the gonadal part of the radial canal is laterally compressed like a broad band and somewhat sinuous. Beside the specimens here mentioned the Zoological Museum possesses a number of fairly small specimens from Danish waters.

The species is previously known only from rather few localities, viz. Bergen (Browne 1903), Cromarty Firth (Romanes), Firth of Clyde (Browne 1905 a), Port Erin (Browne 1895 and 1905 a), and perhaps Plymouth (Browne, 1905, is not quite sure that the specimen of "*Mitrocomella fulva*" from Plymouth belongs to the present species). The known area of distribution is now extended to comprise the Faeroe Islands and the Danish waters from the Slugen (near Esbjerg) to Anholt Knob in the Kattegat.

At Port Erin and in the Firth of Clyde it was found in June and July; moreover Browne found many large specimens at Port Erin in May and quite young stages at the end of April 1894. The comparatively large specimens examined by me from the Faeroe Islands, the coast at Bergen, and the North Sea have all been found in May. The specimens from the Danish waters, which are all fairly small, have been taken on the following dates: Slugen September 29th, Horns Rev September 11th and November 9th, Skagerrak June 1st and Juli 29th, Anholt Knob November 2nd.

The data now at hand do not constitute a sufficient base on which to give a reliable picture of the life history of the medusa. As large specimens have been found in the spring, the medusa must be able to pass the winter and thus to breed in the spring; but it seems also that the breeding may take place in the summer time, as the specimen described by Browne from Firth of Clyde, taken on June 27th, contained large eggs, many of which were "ready for liberation"; the specimen in question was only 10 mm in diameter, so that the size, at which the medusa becomes mature, is subject to much variation.

Genus *Cosmetira* (Forbes) Hartlaub.

Forbes (1848, p. 42) divided the genus *Thaumantias* into two subgenera, *Cosmetira* with two kinds of tentacles, *Thaumantias* with only one kind of tentacles. The genus *Cosmetira* was again defined by Hartlaub (1909, pp. 82—89). It is characterised as *Mitrocomida* with 4 radial canals, 8 marginal vesicles, and with dwarf-tentacles between the proper tentacles. The genus comprises the following species: *Cosmetira pilosella* Forbes, *C. megalota* (Maas), and the antarctic *C. frigida* Browne; the latter was described by Browne (1910, p. 35) from some badly preserved specimens, and only provisionally referred to this genus.

Cosmetira pilosella Forbes.

Thaumantias (Cosmetira) pilosella Forbes 1848, British Naked-eyed Medusæ. — p. 42. Pl. VIII, fig. 1.

i. p. *Laodice cruciata* Haeckel 1879, System der Medusen. — p. 132.

Euchilota pilosella Browne 1896, British Hydroids and Medusæ. — Proc. Zool. Soc. London, 1896. — p. 484. Pl. XVI, figs. 7, 7 a.

Cosmetira pilosella Hartlaub 1909. Ueber *Thaumantias pilosella* Forbes und die neue Lafoëiden-Gattung *Cosmetira*. — Zool. Anz. Bd. 34. — p. 82.

Umbrella much rounded, about 20 mm wide. Stomach small, with a cross-shaped base and 4 folded lips. Gonads narrow, linear, somewhat sinuous, placed along the 4 radial canals, leaving both ends free. About 64 short tentacles with globular basal bulbs; between each successive pair of tentacles there are about 6 short, solid dwarf-tentacles; a number of similar organs are distributed over the outer part of the exumbrella. There are 8 large, open, adradial marginal vesicles. Velum is broad. Stomach and gonads are reddish-purple, tentacle-bulbs dark purple.

Forbes's description and particularly his coloured drawings of this species are excellent. Among others the following remark is appropriate: "... towards the margin ... it is as if woolly ...". Forbes, it is true, did not observe the marginal vesicles; these have first been described by Gosse (1853), who also mentions the high illuminating power of the animal. Haeckel included Forbes's medusa among his numerous synonyms of "*Laodice cruciata*", and this has caused a good deal of confusion. Thus the "*Laodice cruciata*" of Garstang (1893—1895, pp. 215 and 233 ff.) and Browne (1895, p. 276) is actually *Cosmetira pilosella*, as later demonstrated by Browne. On the other hand, the medusa which in Crawford (1891) and McIntosh (1890) is called "*Laodice cruciata* (*Thaumantias pilosella* Forbes)" is a real *Laodicea* (see above, p. 28). In 1896 Browne (1896, p. 484. Pl. XVI, figs. 7 and 7 a) identified some medusæ, examined by him, as Forbes' species, which he referred provisionally to the genus *Euchilota*, and thereafter we find it in the literature under the name of *Euchilota pilosella* until 1909, when Hartlaub (1909, pp. 82—89) gave a new definition of the genus *Cosmetira* and a new and thorough description of the type-species *pilosella*, based on some specimens from Bergen previously identified by Broch (1905, p. 7) as *Ircne viridula*. The name *Cosmetira pilosella* has been adopted by Mayer (1910, p. 261) and Browne (1910, p. 32). In Bedot's *Histoire des Hydroïdes*, on the other hand, it is unfortunately mentioned as a synonym of "*Laodice cruciata*"¹.

I have no objections or additions to Hartlaub's thorough description. Hartlaub calls attention to the fact that the "cirri" are fairly short and rigid threads and are never spirally coiled; they are, accordingly, no typical cirri and ought to be called dwarf-tentacles.

Material (see Chart VII):

Lat. 59°48' N., Long. 1°23' W., close south of the Shetland Islands. July 22nd 1905. Depth 85 m. "Thor" stat. 122 (05). — 3 specimens.

In the journal of the "Thor" from this station only one species of Leptomedusæ is recorded, and a roughly made sketch makes it probable that it means the present species. It was taken in the young-fish trawl with 25 m wire in great quantities, with 65 m wire commonly, and with 125 m wire in smaller numbers. It is possible that the specimens from the deepest haul have been captured during the hauling up through the upper water-layers, where the species, according to the journal, was present in great numbers.

The area of distribution of this species is fairly narrowly limited. It has been found near Bergen (Broch 1905, Hartlaub 1909), at the Shetland Islands (Forbes 1848), at the Isle of Man (Browne 1895), Valencia Harbour (Browne 1895 and 1900, Delap 1905), Falmouth (Alder in For-

¹ Compare the note on p. 21.

bes 1848), Plymouth (Garstang 1893—95, Lebour 1917); it is mentioned in the International Plankton Bulletins from the Bristol Channel and the British Channel every year in May and August.

The present author has seen this species in great quantities during his stay at Plymouth in 1914. It was found for the first time on the night between May 19th and 20th, 7 miles south of Eddystone lighthouse; the individuals were of different sizes, none were fully grown; it was found again on nearly the same spot on the night between May 25th and 26th and further until June 11th con-

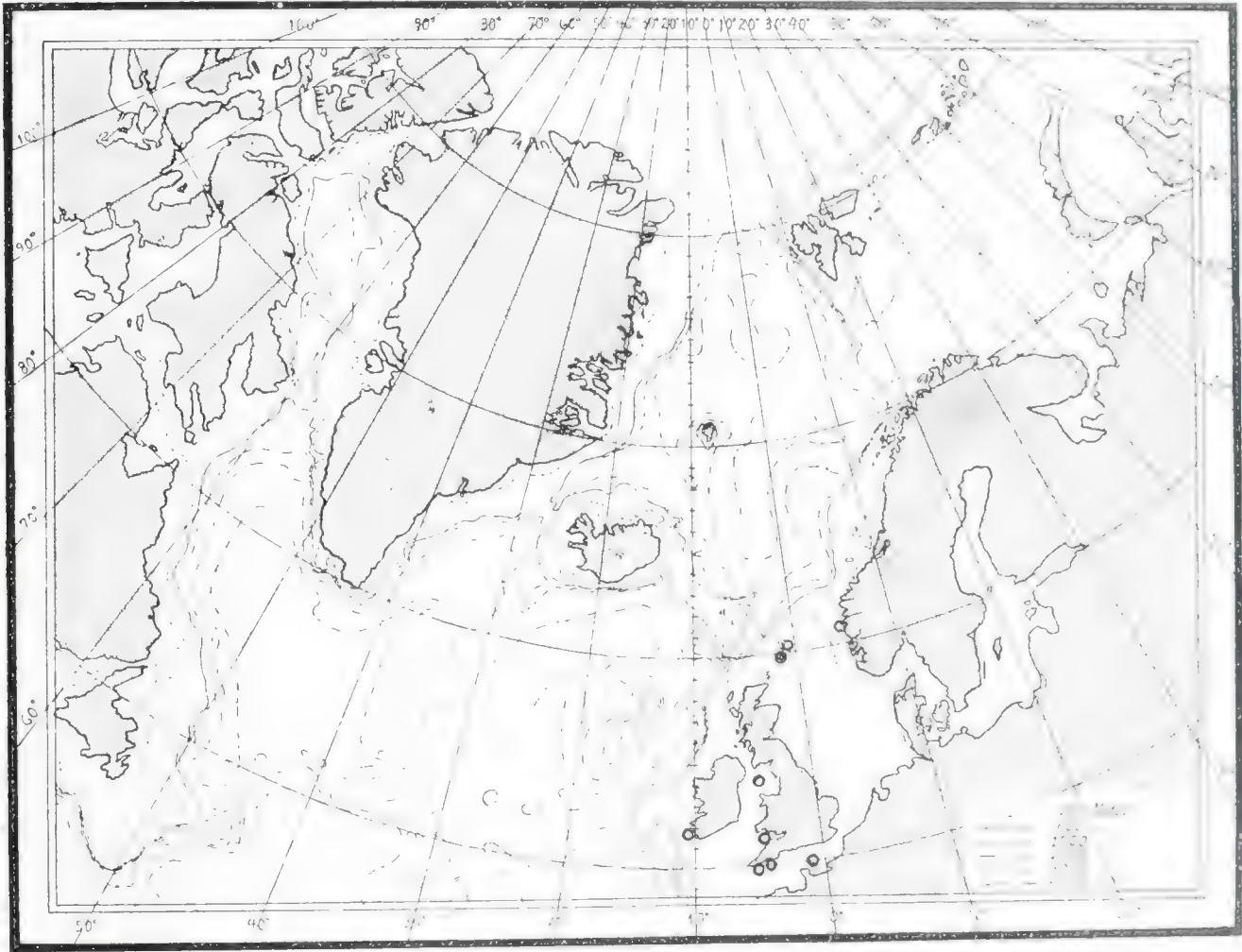


Chart VII. Occurrence of *Cosmetira pilosella* Forbes. ○ Occurrence according to the literature

stantly in large numbers, but still no full-grown specimens. Plankton samples taken nearer the shore in the neighbourhood of Plymouth during the same space of time contained no specimens of this medusa.

According to Garstang (1893—95, pp. 233 ff.) and Lebour (1917, p. 161) it appears at Plymouth in May or June, is one of the most predominant medusæ in July and August, and disappears in September. At Valencia Harbour it has been found from the end of April until October (Browne 1899, p. 484 and 1900, p. 719; Delap 1905, p. 11). Browne has found quite young specimens at Valencia Harbour both in May and in August. Moreover a tiny medusa (with 2 tentacles), found at Plymouth in September 1895, is considered to belong to this species. As mentioned above, I found no full-grown

individuals at Plymouth as late as June 11th; the Misses Delap, on the other hand, found large specimens at Valencia Harbour on May 28th 1900; some of these specimens spawned in the aquaria, and the eggs developed into planulæ and further to small hydroids.

The statement of the last-mentioned authors shows that in certain localities the species may breed as early as about June 1st, but all other records as well as my own observations indicate that

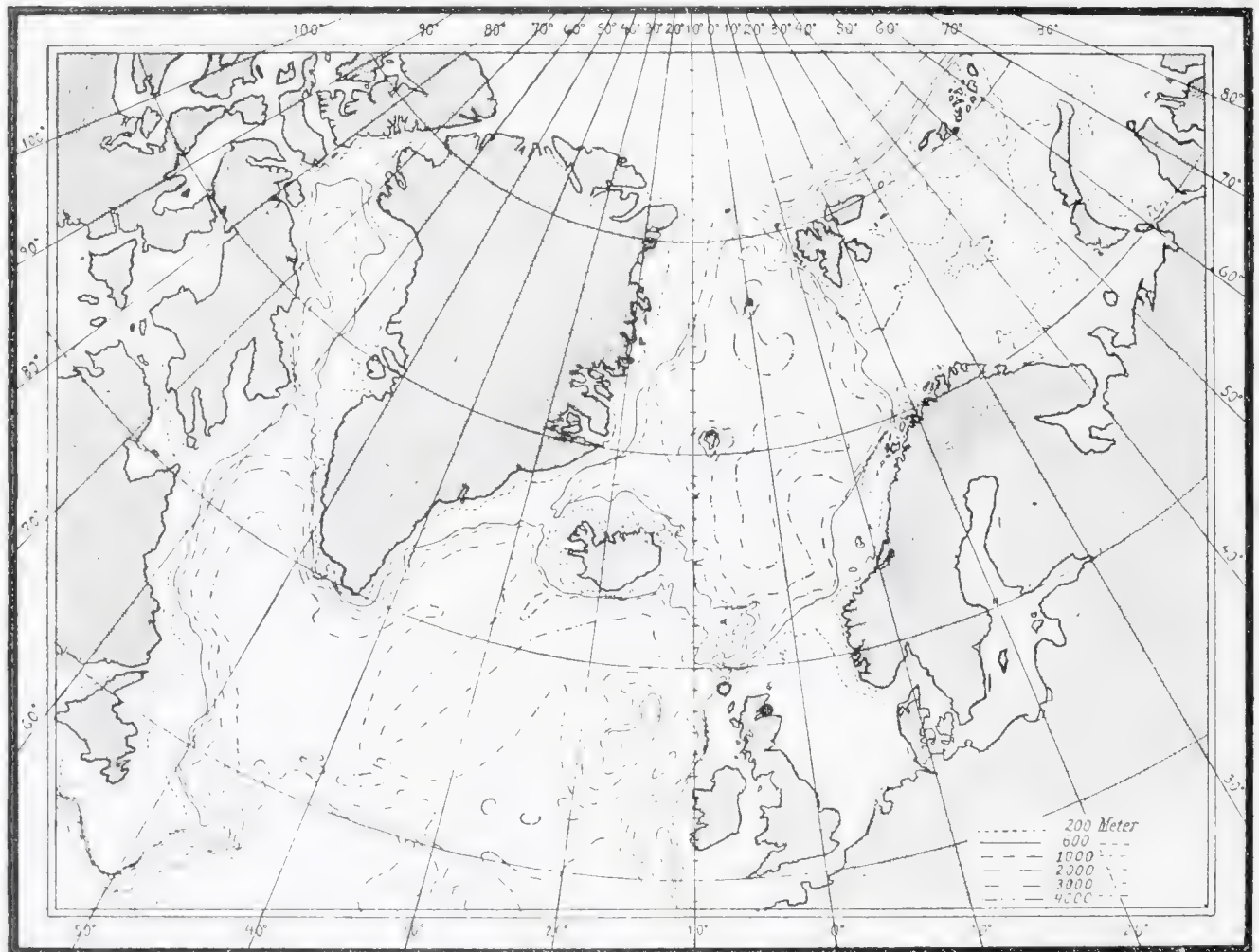


Chart VIII. Occurrence of *Cosmetira megalotis* (Maas). O Occurrence according to the literature.

the medusæ reach maturity in the late summer months, and that the hydroid generation, which has never been found in nature, passes the winter and deliberates the young medusæ in the early spring.

Cosmetira megalotis (Maas).

Halopsis megalotis Maas 1893, *Ergebn. d. Plankton-Exped. Bd. II. K. c.* — p. 57. Taf. VI, Fig. 3, 4, 5, 6.

Mitrocoma megalota Mayer 1910, *Medusæ of the World.* — p. 289.

Cosmetira megalotis Browne 1910, *National Antarctic Exped., Nat. Hist. Vol. V.* — p. 33.

This medusa was taken by the Plankton-Expedition north-west of Scotland on July 19th 1889; has not been found again since it was described by Maas.

The species is very like *Cosmetira pilosella*; it is, however considerably larger (about 30—40 mm wide) and has a greater number of tentacles (about 100 against 64) and about 800 dwarf-tentacles; the tentacle-bulbs are less broad. The stomach is larger, and the gonads are shorter, extending along the outer one-third or half part of the 4 radial canals. The marginal vesicles seem to be somewhat more flattened.

The Zoological Museum of Copenhagen possesses 2 specimens from the following locality (see Chart VIII):

Murray Firth. September 4th—5th 1904. "Thor". — 2 specimens.

The specimens are 25—30 mm wide. They have about 100 tentacles and about 8 times as many dwarf-tentacles, most of which are placed on the bell-margin itself, some being, however, displaced a little upwards upon the exumbrella. There are 8 large, flat marginal vesicles. The gonads occupy the distal half-part of the radial canals but do not quite reach the circular vessel. The larger specimen is a male, the smaller one is a female.

The specimens agree very well with Maas's description. Maas, however, does not mention the fact that the dwarf-tentacles may partly be situated on the exumbrella at a little distance above the bell-margin. Moreover it is not appropriate to state, that the shape of the umbrella is flat; this medusa has the same bent-down margin as *Cosmetira pilosella*. The specimens are preserved in alcohol; the dark pigmentation has disappeared, and the tentacle-bulbs as well as the manubrium and the gonads have now a dirty-yellow colour.

The possession of 8 large, open marginal vesicles and the short and rigid (not spirally coiled) dwarf-tentacles put it beyond doubt that this medusa belongs to the genus *Cosmetira*.

Genus *Halopsis* A. Agassiz.

Halopsis ocellata A. Agassiz.

Plate IV, figs. 1, 2, 3, 4, 5. Textfigs. 6, 7, 8, 9 a—r.

Halopsis ocellata A. Agassiz 1863, Mode of Development of the marginal tentacles of ... Medusæ. — Proc. Boston Soc. Nat. Hist. Vol. IX. — p. 219.

— — A. Agassiz 1865, North American Acalephæ. — p. 99. Figs. 143—150.

— — Haeckel 1879, System der Medusen. — p. 217.

— — Fewkes 1888 a. On certain Medusæ from New England. — Bull. Mus. Comp. Zool. Harvard Coll. Vol. XIII, No. 7. — p. 233. Pl. III, fig. 3.

— — Hargitt 1904. Medusæ from the Woods Hole Region. — Bull. U. S. Bureau of Fisheries. Vol. 24. — p. 51.

— — Mayer 1910. Medusæ of the World. — p. 323.

— — Bigelow 1914 a. Explorations in the Gulf of Maine July and August, 1912. — Bull. Mus. Comp. Zool. Harvard Coll. Vol. 58, No. 2. — p. 102.

Description: Umbrella is watchglass-shaped, the gelatinous substance comparatively thick, particularly so in the central part of the disk, evenly diminishing in thickness towards the margin.

The diameter of the largest specimen at my disposal is about 56 mm. The manubrium consists of a flattened stomach (Plate IV, fig. 1), circular or star-shaped in outline, and a short mouth-tube. The diameter of the stomach is about one-fifth the diameter of the disk. The length of the mouth-tube of a well-grown specimen is about 4 mm, its diameter at the narrowest part about one-half the diameter of the stomach. The lower (distal) part of the mouth-tube is somewhat expanded, divided into 4 folded lips separated by 4 slight incurvations, not by deep incisions. The stomach is fastened to the subumbrella along the edges of the proximal parts of the radial canals, thus a number of triangular pouches existing between the subumbrella and the dorsal wall of the stomach. The number of radial canals varies (in the present material) from 12 to 17; the canals are arranged in four clusters (Plate IV, fig. 1). From the central point four canals issue, each of which is very soon divided into 3—5 branches; as a rule the branching is completed within the outline of the stomach, so that apparently the radial canals arise separately from the periphery of the latter. The fully developed canals reach the circular vessel,



Fig. 6.

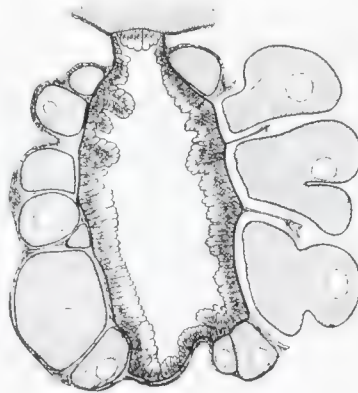


Fig. 7.

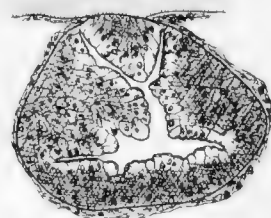


Fig. 8.

Fig. 6. *Halopsis ocellata* A. Agassiz. Transversal section through a radial canal with male gonads. $\times 85$. — Fig. 7. *Halopsis ocellata* A. Agassiz. Transversal section through a radial canal with female gonads. Three of the eggs are ready for liberation. $\times 120$. — Fig. 8. *Halopsis ocellata* A. Agassiz. Transverse section through the distal part of a radial canal, free of gonads. Obs. the high development of the entoderm and the narrow lumen. $\times 240$.

but sometimes we may find young canals terminating blindly somewhere on the subumbrella (textfigs. 9 c, f, h, k). The points of connection between the radial canals and the circular vessel are, as a rule, not equidistant. The stomach sends out a short conical prolongation along each of the radial canals (Plate IV, figs. 1 and 5). The lines of attachment of the radial canals to the subumbrella are very narrow (Plate IV, figs. 1 and 5; textfigs. 6, 7, 8). The gonads (Plate IV, figs. 1, 3, 4; textfigs. 6 and 7) are situated along the radial canals, forming a narrow, somewhat folded band on each side of the canal, leaving both ends free. The gonads commence at a distance of 2—7 mm from the periphery of the stomach and terminate 1—2 mm from the circular vessel. The dorso-ventral extension of the gonadial bands comprises nearly the whole of the lateral walls of the canals, commencing very close to the subumbrella and ventrally leaving but a very narrow line to separate the gonads of the two sides (textfigs. 6 and 7). In the short distal part of the radial canals, free of gonads, the entoderm is highly developed, so that in this part the lumen of the canal is quite narrow (textfig. 8).

There is a large number of hollow tentacles (Plate IV, fig. 2), fairly long and very contractile;

the tentacular bulbs are broadly conical; the number of tentacles amounts to at least about 450. Between every successive pair of tentacles there is one long, fine, solid cirrus (more seldom two cirri), which may coil itself spirally. The marginal vesicles are large open folds of the velum, containing a large number of lithocysts. The number of marginal vesicles between two successive radial canals is very variable according to the distance between the points of termination of the canals; the average number is 5—6. The velum is 2.5—3 mm broad. — The specimens, preserved in formaline or alcohol, are colourless.

The genus *Halopsis* was established by A. Agassiz (1863 and 1865) as a genus belonging to the family *Æquoridae* and containing the species *H. ocellata* with about 16 radial canals, and *H. cruciata* with 4 radial canals. In Haeckel's *System der Medusen* (1879) *Halopsis ocellata* remained among the *Æquoridae*, whereas *Halopsis cruciata* became the representative of a new genus *Phialis* of the *Eucopidae*. — As mentioned above (p. 58), Metschnikoff (1886 a, 1886 b) established a new family for Leptomedusæ with open marginal vesicles, the family which we now call *Mitrocomidae*, and he referred *Halopsis cruciata* as well as *ocellata* to this family. He was followed in this respect by Maas and Torrey, whereas Browne (1910) thought it more correct to await a closer investigation of the marginal vesicles of *Halopsis ocellata*, before it should be definitively included in the family *Mitrocomidae*. Such an investigation was carried out by Bigelow (1914 a), and the systematical position of the species is thus stated. In Mayer, *Medusæ of the World* (1910) *Halopsis ocellata* is still placed among the *Æquoridae*.

A. Agassiz (1865) has given a thorough description of this species. True, the marginal vesicles are called "large compound eyes", but the drawings (figs. 146 and 147) leave no doubt but that they are identical with the large open marginal vesicles. The North-European specimens, examined by me, agree in every regard with Agassiz's description of the American *Halopsis ocellata*. Agassiz states, it is true, that the mature individuals are 2—2½ inches in diameter (= 50—65 mm), whereas the European specimens reach maturity when about 35 mm wide and, according to the material hitherto known, do not exceed 56 mm in diameter. It must be remembered, however, that I have only measured preserved specimens, and the size becomes usually somewhat reduced by the preservation. But even though the European specimens do not, as a rule, reach quite the size of the American specimens, the agreement with regard to the shape is so complete that there can be absolutely no doubt, but that they belong to the same species. — Agassiz has examined young specimens and found that they have only 4 radial canals.

The species, described by Agassiz, was seen again, for the first time, by Fewkes (1888 a, p. 233), who found individuals up to 6 inches in diameter. His specimens differ from the type by the fact that "the radial canals arise regularly, not in four groups, from the stomach cavity". This may depend, I think, on the fact mentioned above, that the branching of the radial canals takes place and is completed inside the periphery of the stomach, so that the canals are completely separated when leaving the latter. The same "independent origin of the radial canals" has been observed by Bigelow (1914 a, p. 102), who found four fragmentary specimens of the species.

The mode of origin of the radial canals was the chief character by which Agassiz would

separate the genera *Halopsis* and *Stomobrachium*. It is very probable that the two genera cannot be kept apart. But nothing definitely can be stated about the matter, as the two species of *Stomobrachium* (*lenticulare* Brandt and *tentaculatum* A. Agassiz) are very deficiently described and have never been found again since the original descriptions were published (Brandt 1835, p. 358. Taf. III, Fig. 6, 7. — A. Agassiz 1865, p. 98, figs. 140—142). Neither cirri nor marginal vesicles have been observed in any of the species of *Stomobrachium*.

Halopsis ocellata has never been recorded from the European waters, though it is actually not uncommon in the Atlantic between the British Isles and Iceland¹.

A few of the specimens at my disposal are in the collection of the Plankton Laboratory in Copenhagen. The medusæ of that collection are mostly identified by Professor Damas, who has labelled the specimens of *Halopsis ocellata* as *Stomobrachium norvegicum*. I have never seen this name mentioned in the literature, and Dr. Browne, on inquiry, has informed me that neither he knows that name. Damas has possibly been of opinion that the specimens represented a new species; but a description was never published. Owing to the war I have not been able to communicate with Professor Damas concerning the matter; a letter, sent to him, has never been answered and has, probably, not reached him. As mentioned above, I consider it to be beyond any doubt that this North-European medusa is identical with the North-American *Halopsis ocellata* A. Agassiz.

Material (see Chart IX):

Iceland:

1) — Lat. 63°43.5' N., Long. 22°22' W., south of Reykjanæs. July 8th 1904. Depth 109 m. "Thor" stat. 174 (04). — 2 specimens.

2) — Lat. 63°18' N., Long. 21°30' W., south of Eyrarbakki. July 8th 1904. — Depth 178 m. Young-fish trawl, 70 m wire. "Thor" stat. 176 (04). — 1 specimen.

3) — Lat. 62°43' N., Long. 20°42' W., south of the Vestman Islands. July 9th 1904. Young-fish trawl, 50 m wire. "Thor" stat. 179 (04). — 2 specimens.

4) — The Gulf at Heimaey, Vestman Islands. August 7th 1905. "Beskytteren", Fr. Johansen. — 1 specimen.

5) — South of the Myrdalsjökul. August 17th 1903. "Michael Sars". — 3 specimens.

6) — Under Iceland. August 16th 1903. "Michael Sars". — 5 specimens.

7) — Lat. 64°04' N., Long. 13°48.2' W., Myri Bay. July 24th 1904. Depth 68 m. "Beskytteren", Gemzoe. — 3 specimens.

8) — Lat. 64°35' N., Long. 11°45' W., off the south-eastern coast of Iceland. August 8th 1904. Depth 348 m. Young-fish trawl, 20 or 70 m wire. "Thor" stat. 241 (04). — 3 specimens.

9) — Lat. 63°12' N., Long. 11°45' W., between Iceland and the Faeroe Islands. August 7th 1904. Young-fish trawl, 20 m wire. "Thor". — 4 specimens.

10) — Lat. 61°34' N., Long. 18°43' W., south of Iceland. July 10th 1904. Young-fish trawl, 15 m wire. "Thor" stat. 181 (04). — 2 specimens, in the collection of the Plankton Laboratory, Copenhagen.

¹ Günther (Report on the Coelenterata ... of the North Atlantic. — Ann. Mag. Nat. Hist., ser. 7, vol. XI, 1903, p. 426) mentions two small medusæ which "bear a considerable resemblance to the young of *Halopsis ocellata* as described by Agassiz", but from his description it does not seem probable that the specimens have belonged to that species.

West of Scotland:

11) — East of Rockall. July 28th 1913. 150 m wire. "Armauer Hansen" stat. 17 (1913). — 1 specimen, in Bergens Museum.

12) — Lat. $57^{\circ}03' N.$, Long. $11^{\circ}20' W.$ May 28th 1908. Young-fish trawl, 65 m wire. "Thor" stat. 12 (08). — 1 specimen.

13) — Lat. $56^{\circ}56' N.$, Long. $9^{\circ}01' W.$ May 28th 1908. Depth 140 m. Young-fish trawl, 65 m wire. "Thor" stat. 11 (08). — 1 specimen.

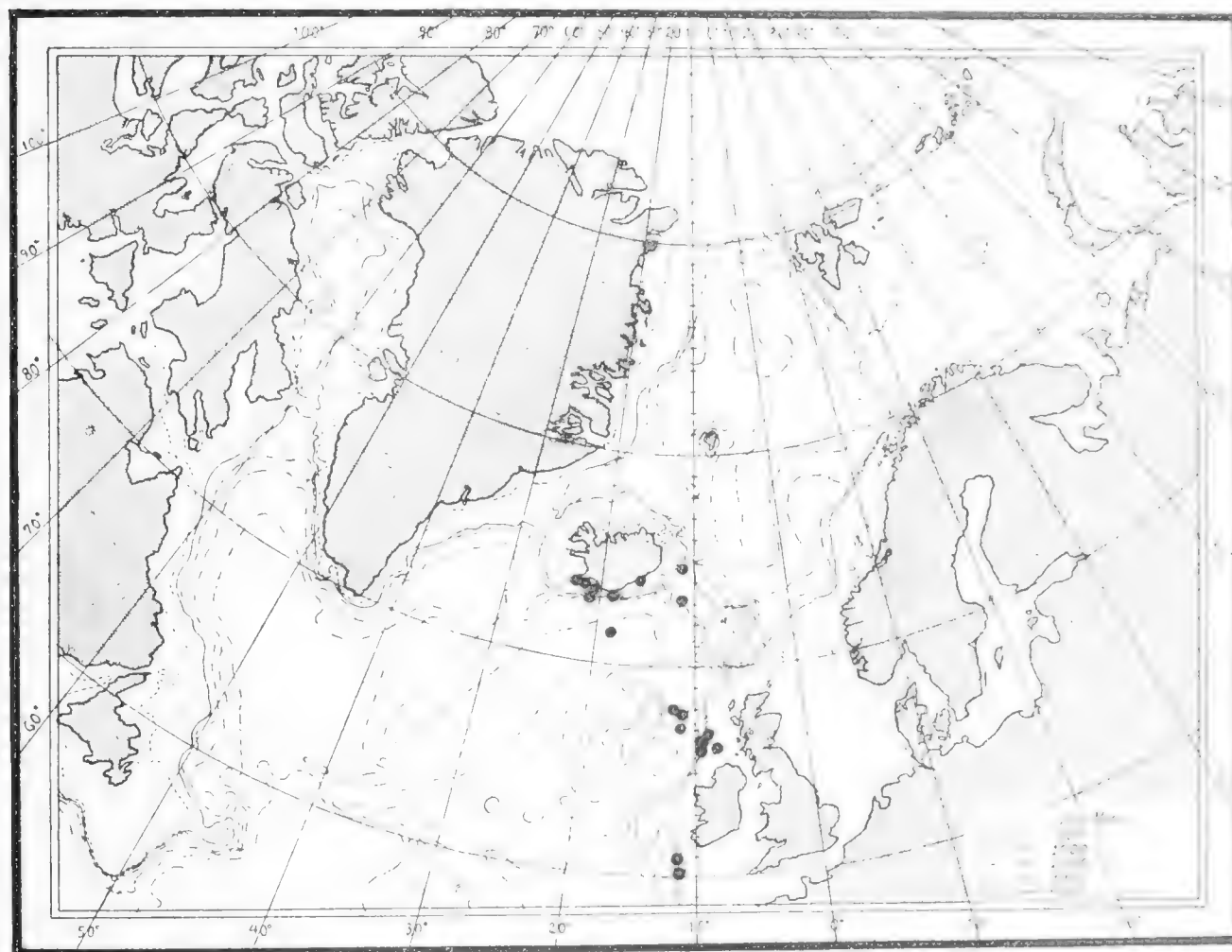


Chart IX. Occurrence of *Halopsis ocellata* A. Ag. in the north-eastern Atlantic

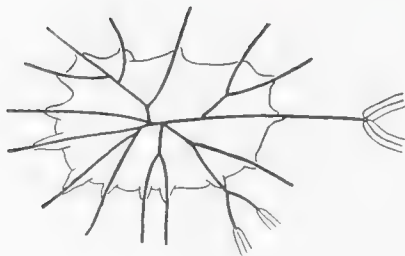
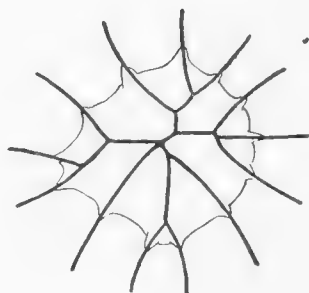
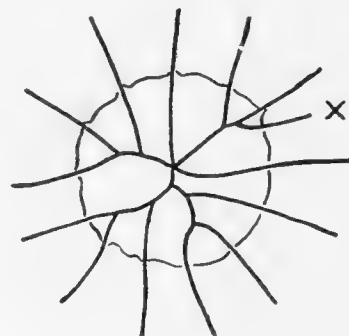
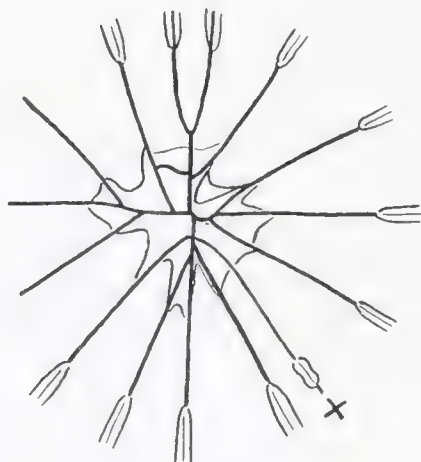
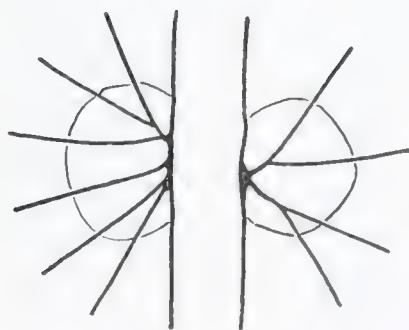
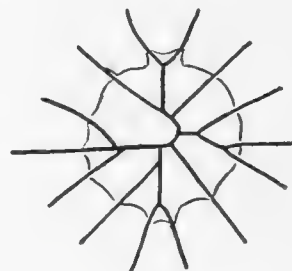
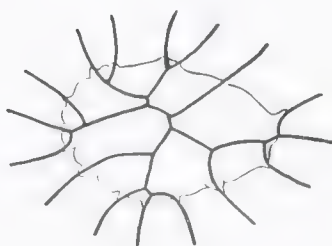
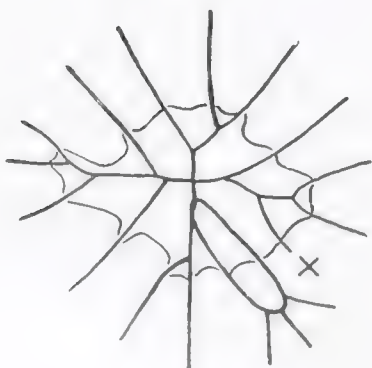
14) — Lat. $56^{\circ}00' N.$, Long. $9^{\circ}32' W.$ June 10th 1905. Depth 1040 m. Young-fish trawl. 300 m wire. "Thor" stat. 74 (05). — 1 specimen.

South-west of Ireland:

15) — Lat. $51^{\circ}00' N.$, Long. $11^{\circ}43' W.$ June 15th 1905. Depth 840—1400 m. Young-fish trawl, 200 m wire. "Thor" stat. 82 (05). — 1 specimen, in the collection of the Plankton Laboratory, Copenhagen.

Moreover from the "Michael Sars" 1910:

a) — Lat. $57^{\circ}41' N.$, Long. $11^{\circ}48' W.$, between the Hebrides and Rockall. August 6th—7th 1910.

*a**b**c**d**e**f**h**i**l*

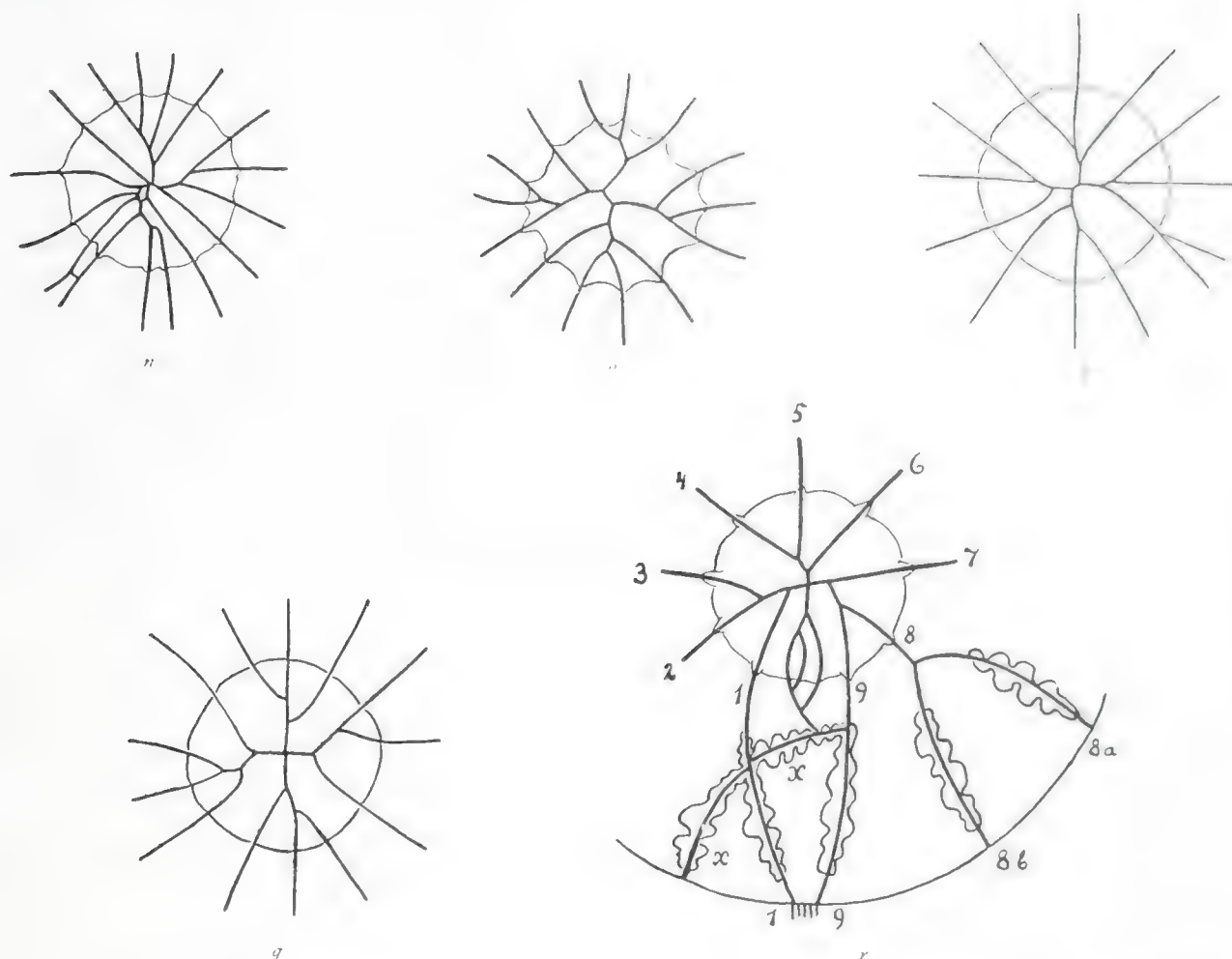


Fig. 9 a-e. *Halopsis ocellata* A. Agassiz. Diagrams of the stomachs and the proximal parts of the radial canals of different specimens, seen from the apical side. For further explanation, see the text, pp. 71-73.

Depth 1853 m. Stat. 101. — Young-fish trawl, 1000 m wire: 1 specimen. — Ringtrawl, 200 m wire: 1 specimen.

b) — Lat. $56^{\circ}33'$ N., Long. $9^{\circ}30'$ W., south-west of the Hebrides. August 5th 1910. Depth 1000—1360 m. Ringtrawl, 200 m wire. Stat. 98. — 1 specimen.

c) — Lat. $56^{\circ}15'$ N., Long. $8^{\circ}28'$ W., between the Hebrides and the north coast of Ireland. August 4th 1910. Depth 139 m. Ringtrawl, 50 m wire. Stat. 97. — 2 specimens.

d) — Lat. $50^{\circ}13'$ N., Long. $11^{\circ}23'$ W., south-west of Ireland. July 26th 1910. Depth 1565 m. Ringtrawl, 1500 m wire. Stat. 94. — 1 specimen.

Remarks on the individuals.¹

Loc. 1. — Specimen No. I (textfig. 9 a): Diameter about 30 mm, ♂, 14 radial canals, regularly arranged in 4 groups of 3-3-4-4 canals. — Specimen No. II (textfig. 9 b): Diam. 35 mm, ♀, 17 radial

¹ The individuals from Loc. a, b, c, and d are mentioned in my paper on the Anthomedusæ and Leptomedusæ from the "Michael Sars" North-Atlantic Expedition in 1910.

canals, two of which are not separated until so far outside the periphery of the stomach that their gonads are confluent (Plate IV, fig. 5); the canals are very irregularly arranged.

Loc. 2. — (textfig. 9 *c*): Diam. 24 mm, ♀, 17 radial canals, one of which (x) is quite young and terminates blindly; arrangement irregular.

Loc. 3. — Specimen No. I (textfig. 9 *d*; Plate IV, figs. 1 and 3): Diam. 35 mm, ♂, mature, 15 radial canals, regularly arranged in 4 groups of 3-4-4-4 canals. — Specimen No. II (textfig. 9 *e*): Diam. 45 mm, ♀, gonads containing eggs of different sizes; 13 radial canals in groups of 3-3-3-4; 442 tentacles (with regard to the distribution of the tentacles in relation to the radial canals, see below).

Loc. 4 (Plate IV, fig. 2): Diam. 35 mm, ♀, 15 radial canals, fairly regularly arranged in groups of 3-3-4-5.

Loc. 5. — Specimen No. I (textfig. 9 *f*): Diam. 25 mm, ♂, 14 radial canals, irregularly arranged, one of the canals (x) is quite young and terminates blindly. — Specimen No. II: Diam. 26 mm, ♂, 17 radial canals, 5-4-4-4, in the third group one small blind canal. — Specimen No. III (textfig. 9 *g*): Diam. 33 mm, ♂; the specimen has 2 stomachs; 6 canals issue from the one of the stomachs, 8 from the other. The distance between the stomachs is 2 mm. The dimensions of the stomachs are, respectively, 3.8 by 3.0 mm and 4.0 by 2.7 mm.

Loc. 6. — Specimen No. I: Diam. 28 mm, ♀, 15 radial canals, 3-5-3-4. — Specimen No. II: Diam. 32 mm. — Specimen No. III: Diam. 36 mm, ♂, 15 radial canals. — Specimen No. IV: Diam. 37 mm. — Specimen No. V: Diam. 40 mm.

Loc. 7. — Specimen No. I (textfig. 9 *h*): Diam. 23 mm, ♂, 15 radial canals, one of which ends blindly (x), but has already a short gonad. — Specimen No. II (textfig. 9 *i*): Diam. 28 mm, ♂, 14 radial canals, 4-4-3-3. — Specimen No. III (textfig. 9 *k*): Diam. 40 mm, ♀, 17 radial canals, 3-4-5-5. Two of the canals, issuing from the periphery of the stomach, make an anastomosis, from which 3 canals issue. In the 2nd group there is a young canal (x) beginning to develop.

Loc. 8. — Specimen No. I (textfig. 9 *l*): Diam. 30 mm, ♀, 16 radial canals, irregularly arranged. — Specimen No. II: Diam. 35 mm, ♂, 15 radial canals, 3-4-3-5. — Specimen No. III: Diam. 35 mm, ♂, 17 radial canals.

Loc. 9. — Specimen No. I: Diam. 30 mm, ♀, 15 radial canals. — Specimen No. II (textfig. 9 *m*): Diam. 30 mm, ♂, 15 radial canals, irregularly arranged. — Specimen No. III (textfig. 9 *n*): Diam. 44 mm, ♂, sexual products spawned, 16 radial canals, irregularly arranged. 428 tentacles and 80 marginal vesicles (see below). — Specimen No. IV (textfig. 9 *o*): Diam. 56 mm, ♀; the individual has spawned, but the gonads still contain some eggs. 14 radial canals, 3-3-4-4. 83 marginal vesicles (see below); the tentacles cannot be counted.

Loc. 10. — Specimen No. I: Diam. 33 mm, ♂, 15 radial canals, 3-3-4-5. Specimen No. II: Diam. 34 mm, ♂, 15 radial canals.

Loc. 11. — Diam. 45 mm, ♀, fully mature, 15 radial canals.

Loc. 12. — Diam. 40 mm, ♂, 12 radial canals, 3-3-3-3.

Loc. 13 (textfig. 9 *p*): Diam. 35 mm, ♀, 13 radial canals, 3-3-3-4.

Loc. 14 (textfig. 9 *q*): Diam. 30 mm, ♂, 13 radial canals, 3-3-3-4.

Loc. 15 (textfig. 9 *r*): Diam. 20 mm, ♀. The radial canals are abnormally arranged. 12 canals

leave the periphery of the stomach, 3-3-3-3, and 11 canals reach the circular vessel. One of the quadrants is stunted, pressed between the neighbours; in connection herewith it must be remarked that the specimen is unusually highly arched. The arrangement of the canals is as follows:

Group I. 3 canals (marked 1, 2, and 3 in the figure) leave the stomach and reach the circular vessel (as to No. 1, see below).

Group II. 3 canals (4, 5, 6) leave the stomach and reach the circular vessel in normal way.

Group III. 3 canals (7, 8, 9) leave the stomach. No. 7 reaches the circular vessel normally; No. 8 divides into 8*a* and 8*b*, both of which reach the circular vessel. No. 9 runs to the margin and reaches the circular vessel so near No. 1, that there is only room for 3 tentacles between the two canals. On the way towards the margin No. 9 sends out a branch (*x*), which, crossing No. 1, runs towards the margin and reaches the circular vessel between No. 1 and 2, nearest to No. 1.

Group IV. 3 canals leave the stomach, all very close together, and unite just outside the stomach into one canal, which opens into the link canal *x* between 9 and 1, nearest to No. 9.

The arrangement of the gonads on the abnormal radial canals is sketched in the figure.

Only in a few cases it has been possible to count the tentacles and marginal vesicles.

Loc. No. 3, specimen No. II (diam. 45 mm) has 442 tentacles, the distribution of which in relation to the 13 radial canals will be seen from the following scheme:

Off the 13 radial canals	13 tentacles
Group I 19 + 49 + 30	= 98 —
— II 25 + 34 + 27	= 86 —
— III 46 + 29 + 34 + 32	= 141 —
— IV 29 + 37 + 38	= 104 —
Total...	442 —

Thus the number of tentacles between two successive radial canals varies, in this specimen, from 19 to 49.

Loc. No. 9, specimen No. III (diam. 44 mm) has 16 radial canals (arrangement irregular), 428 tentacles, and 80 marginal vesicles, distributed between the radial canals in the following manner:

Tentacles.....	10	29	28	16	31	23	25	28	31	20	11	36	28	36	29	31
Marginal vesicles	1	7	6	2	5	4	5	4	8	3	3	6	9	6	5	6

Thus in the present case the number of tentacles between two successive radial canals varies from 10 to 36, the number of marginal vesicles from 1 to 9. The average number of marginal vesicles between two canals is 5.35, the average number of tentacles between two successive marginal vesicles is 5.70. The arrangement of the marginal vesicles is, however, fairly irregular, in so far as two vesicles may be found immediately beside each other.

Specimen No. IV from the same locality (diam. 56 mm) has 14 radial canals (3-3-4-4); the tentacles cannot be counted; there are 83 marginal vesicles, distributed between the radial canals in the following manner:

4 3 5 4 7 8 5 10 3 7 9 5 6 ,

The average number of marginal vesicles between two successive radial canals is 5.9, varying from 3 to 10.

The map (Chart IX) demonstrates that the North-European localities, in which this species has been found, fall into two separated groups: 1) south of Iceland, 2) west of the British Isles. Though these areas are very near each other, there seems, however, to exist an obvious difference between the individuals from the two areas, in any case in one regard, in so far as the specimens from Iceland have a greater number of radial canals than the British specimens of corresponding sizes. In Table VII, which serves to elucidate this fact, the specimens collected by the "Michael Sars" in 1910 are included among the specimens from the British area.

Also with regard to the relation between the diameters of the stomach and the umbrella there seems to be a difference between the British and the Icelandic specimens, the stomach being comparatively larger in the former than in the latter.

Table VII. Numbers of radial canals of specimens of different sizes of *Halopsis ocellata*.

Numbers of radial canals	Diameters of specimens from									
	South of Iceland					West of British Isles				
	21-30 mm	31-40	41-50	51-60	Total	21-30 mm	31-40	41-50	51-60	Total
11	.	.	.	.	.	1	.	.	.	1
12	.	.	.	.	.	.	4	.	.	4
13	.	.	1	.	1	2	2	.	.	4
14	3	.	.	1	4	.	.	.	.	.
15	4	6	.	.	10	.	.	1	.	1
16	1	.	1	.	2	.	.	.	.	.
17	2	3	.	.	5	.	.	.	.	.
Average diameter 33.5 mm						Average diameter 34.7 mm				
Average number of radial canals 15.3						Average number of radial canals 12.6				
22 specimens examined						10 specimens examined				

I have measured the stomachs in 21 Icelandic and 10 British specimens, and I give the figures obtained in Table VIII, at the same time as I expressly remark that too much importance must not at present be applied to the results, the material investigated being rather small. The figures look, however, interesting as far as they indicate the existence of two different local races in areas very near each other; if future investigations should confirm this result, it would be of great interest to the studies of the variation of medusæ.

It will be observed from the table that, as far as the smaller and middle-sized individuals are concerned, the figures representing the proportion between the size of the stomach and that of the umbrella exhibit a somewhat considerable difference between the specimens from the two areas. The figures from Iceland show, moreover, that the stomach grows in size nearly proportionately to the umbrella until the latter has reached a diameter of towards 40 mm; at this size the sexual products

are mature, partly even spawned (see below); thereafter the umbrella continues its growth, whereas the stomach does not further increase in size.

To the measurements presented in the tables VII and VIII one may object that it is difficult to measure the umbrella exactly, because it is very contractive and may, at the preservation, be contracted to a very different degree. This objection is entirely correct, and we must, therefore, take a certain reservation to the figures of the tables. But, on the other hand, the difference between the Icelandic and the British specimens, as shown by the figures of the tables, both with regard to the diameter of the stomach and the number of the radial canals, is so obvious that it can hardly be due to erroneous measurements owing to different contraction of the umbrella. Moreover, when regarding the absolute figures of the dimensions of the stomach, which can be measured fairly exactly, we will find that in most of the British specimens the stomach is actually larger than in the Icelandic specimens. And a comparison of the two tables (VII and VIII) will give the result that the individuals

Table VIII. Correlation between Diameter of Stomach and Umbrella
of *Halopsis ocellata*.

Diameter of umbrella	South of Iceland (21 specim.)				West of British Isles (10 specim.)								
	Diameter of stomach mm				Average diameter of		Pro- portion between stomach and umbrella	Diameter of			Average diameter of		Pro- portion between stomach and umbrella
	4	5	6	7 8	umbrella	stomach		6	7	8 9	umbrella	stomach	
20-25 mm...	1	2	.	.	24	4.7	0.20	1	1	.	21	6.5	0.31
26-30 — ...	1	3	2	.	29	5.2	0.18	.	1	1	29	8.5	0.29
31-35 — ...	.	.	3	1 3	35	7.0	0.20	.	1	2	34	8.7	0.26
36-40 — ...	.	.	2	.	38	7.0	0.18	.	2	1	40	8.3	0.21
41-45 — ...	.	.	2	.	44.5	7.0	0.16	.	.	.	—	—	—
56 — ...	.	.	2	.	56	7.0	0.13	.	.	.	—	—	—

from the area west of the British Isles have, generally spoken, larger stomachs and a smaller number of radial canals, whereas the specimens from the waters south of Iceland have smaller stomachs and a larger number of radial canals, even quite setting aside the total size of the specimens.

The young gonads are straight, but according as the sexual products are developed, the gonads gradually become sinuous; this development commences, when the diameter of the specimen is 20—25 mm. When the individual is 30—35 mm wide the gonads are much thickened and greatly sinuous. The male gonads may have up to 9 bends on either side; the female gonads never become so much thickened or sinuous as the male ones. The maturity is reached, when the animal is about 35 mm wide. Then, in the case of the female, we can see the eggs having penetrated the ectodermal epithelium and being situated freely on the lateral walls of the radial canals, ready to be detached (Plate IV, fig. 4; textfig. 7). When the male gonads become mature, they become much swollen and, besides being sinuous, they get a finely wrinkled surface (Plate IV, fig. 3). — After the ripening and detachment of the sexual products the animal continues its growth. According as the main part of the sexual products are evacuated, the radial canals stretch and become straight again; at the same time the

walls are destructed and detached from the subumbrella, only the narrow entodermal stripe, along which the canal was attached to the subumbrella, remaining. The sexual products are first evacuated in the proximal part of the gonads, so that at a certain moment the radial canals are seen attached to the subumbrella by the parts free of gonads and by the distal part of the gonadial part, from which the sexual products are not yet evacuated, while the part, in which the evacuation has been completed, hangs freely downwards like a bow (see the diagram, textfig. 10). Female individuals, which have evacuated the eggs, are found to measure 40—56 mm in diameter; a male specimen, 44 mm wide, has spawned.

Occurrence:

The occurrence of *Halopsis ocellata* at the coast of North America is limited to the Gulf of Maine from Grand Manan to Cape Cod (A. Agassiz, Fewkes, Bigelow).

The distribution on the European side of the North Atlantic is as follows: The species is common all along the south coast of Iceland, mainly in the neighbourhood of the coast. Hitherto it has not been found at the Faeroe Islands. It is common in the waters between Scotland and Rockall, and has been found, moreover, south-west of Ireland. As mentioned above, it has not previously been recorded from the European waters, thus all our knowledge of its occurrence in that area is based on the material here dealt with. It will be observed from chart IX, that it does not at any point surpass

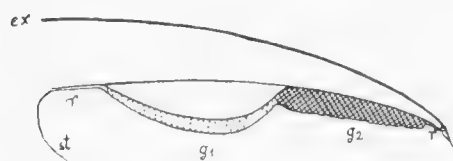


Fig. 10. *Halopsis ocellata* A. Agassiz. Diagram, showing a radial section through the umbrella. — *ex* exumbrella, *g*₁ part of the gonads, from which the sexual products have been evacuated, *g*₂ part of the gonads, still containing sexual products, *r*, *r* proximal and distal parts of radial canal free of gonads, *st* stomach.

the Wyville Thomson ridge. As it has, besides, not been found at the western or northern coasts of Iceland, its distribution may be designated as being entirely Atlantic. The occurrence seems, moreover, to be mainly neritic. Thus during the cruise of the "Armauer Hansen" in 1913 the species was only found on stat. 17, the easternmost station of the expedition, above the deep channel east of Rockall, whereas it was completely absent on all of the westernmost stations.

With regard to the bathymetrical distribution, the data at hand show that the species may be found at very different depths. — The specimens from the south coast of Iceland have all been taken at a fairly short distance below the surface, in no case deeper than about 40 m (with 70 m wire); some of the specimens have undoubtedly been found very close to the surface. The specimens from Loc. No. 10, which is situated comparatively far south of Iceland, were taken with 15 m wire, i. e. close by the surface. — West of Scotland, on the other hand, it has been found, on certain occasions, in considerable depths, thus, for instance, by the "Michael Sars", loc. a, with 1000 m wire. The various depths, in which the species has been found within that area, will be seen from the following figures, representing the length of wire used by the hauls made: 50, 65, 65, 150, 200, 200, 300, and 1500 m, that means between about 30 and about 1000 m below the surface. Of special interest is the station 17 of the "Armauer Hansen", where a specimen was taken in a haul with 150 m wire out, whereas none were found in the deeper hauls (with 600, 1000, and 1300 m wire). — South-west of Ireland 1 specimen was found in a haul with 200 m wire (loc. 15), and 1 specimen in a haul with 1500 m wire ("Michael Sars", loc. d).

The very most of the finds have been made in the months of July and August. West of Scot-

land it has also, however, been found on May 28th and June 10th, and south-west of Ireland a specimen was taken on June 15th. — Mature specimens have been found both at the end of May and in the summer months. Quite young individuals have not been observed; from the present material we can, therefore, state nothing more with regard to the breeding season, than that the spawning of the eggs may take place during the summer. With regard to the further fate of the eggs and the hydroid generation nothing can be stated.

Genus *Tiaropsis* L. Agassiz.

This genus was established by L. Agassiz (1849, pp. 289 ff.) for the North American *Tiaropsis diademata* L. Agassiz. — Browne (1910, p. 33) characterises the genus in the following manner: "*Mitrocomidæ* with four radial canals; with eight sensory pits; with an ocellus adjacent to each sense organ; without marginal cirri". — The genus and its species have recently been dealt with by Browne (1910, p. 33) and Bigelow (1913, p. 32).

The genus comprises, probably, 6 species: *multicirrata* Sars in the eastern and western part of the northern Atlantic and in the northern Pacific (*diademata* Agassiz and *multicirrata* Sars are identical, which shall be further demonstrated below); *macleani* v. Lendenfeld (1884) from Australia; *davisii* Browne (1902) from the Falkland Islands. Common for these three species is the possession of numerous tentacles, all of the same size, whereas the three other species, all of which live in warmer seas, have 4—8 well-developed tentacles and a number of rudimentary ones. The three species are the following: *Tiaropsis rosea* Agassiz & Mayer (1899) from the Fiji Islands (Agassiz & Mayer 1899), Malayan Archipelago (Maas 1905), and Tortugas, Florida (*Tiaropsis diademata* Fewkes 1882, *Tiaropsis punctata* Mayer 1900); *Tiaropsis mediterranea* Metschnikoff (1886) from the Mediterranean; *Tiaropsis kelseyi* Torrey (1909) from the San Diego region, Pacific coast of North America.

The genus *Tiaropsis* has, thus, a very extensive geographical distribution.

Tiaropsis multicirrata (M. Sars.)

Plate IV, figs. 6, 7, 8, 9, 10; textfigs. 11, 12, 13, 14.

Thaumantias multicirrata M. Sars 1835. Beskrivelser og Iagttagelser . . . — p. 26. Pl. 5, fig. 12 a—c.

— *melanops* Forbes 1848. British Naked-eyed Medusæ. — p. 45. Pl. X, fig. 3.

Tiaropsis diademata L. Agassiz 1849. Contrib. Nat. Hist. of the Acalephæ of North America. — p. 289. Pl. 6, figs. 1—18; Pl. 8, fig. 11.

Thaumantias eschscholtzii Haeckel 1879. System der Medusen. — p. 129. Taf. VIII, fig. 4.

Bell flatter than a hemisphere, about 20 mm wide, gelatinous substance not very thick. Stomach fairly small, provided with 4 folded lips; there is a broad, flat stomachal peduncle. 4 straight radial canals, carrying the gonads, which extend from the base of the stomachal peduncle nearly to the circular vessel. About 300 short tentacles with well developed basal bulbs. 8 adradial, open marginal vesicles, each containing about 12 concretions; at the base of each marginal vesicle there is a large, black ocellus. Velum well developed. Stomach and gonads yellowish; the tentacular bulbs contain an entodermal pigment mass and are also provided with fine ectodermal pigment granules.

The particular aim of my studies on this species has been to elucidate the relation between the European form *Tiaropsis multicirrata* M. Sars and the American *Tiaropsis diademata* L. Agassiz, the identity of which appears to be beyond doubt.

Before I enter on a discussion of that question I shall, however, communicate the interesting fact, that "*Thaumantias eschscholtzii*" Haeckel appears to be identical with *Tiaropsis multicirrata*. *Thaumantias eschscholtzii* was described and figured by Haeckel in his *System der Medusen* and has frequently, in text books and manuals, been mentioned as a typical *Thaumantias*. Haeckel's description was based on some specimens from Greenland in the Zoological Museum of Copenhagen. I have seen these specimens and found that the large, black ocelli are so conspicuous, that it seems incomprehensible, how they have escaped the attention of Haeckel, when he examined the individuals in order to describe them. The specimens are certainly the same, which were examined by Haeckel, and not some others, erroneously identified by another person. This is clearly demonstrated by the label being provided with a number referring to a list of the collection of medusæ, then in the museum

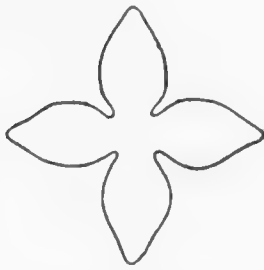


Fig. 11.



Fig. 12.

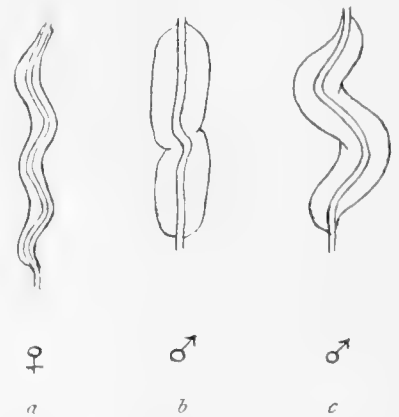


Fig. 13.

Fig. 11. *Tiaropsis multicirrata* Sars. Mouth-lips of a young specimen, 1.5 mm wide. — Fig. 12. *Tiaropsis multicirrata* Sars. Diagram of a young specimen, 1.8 mm wide. — Fig. 13. *Tiaropsis multicirrata* Sars. Radial canals with gonads. *a* female, *b* and *c* male.

of Copenhagen, written by Haeckel with his own hand. Another specimen, from Egedesminde, West Greenland, has been referred by Levinsen (1892) to the species of Haeckel, and I myself, seeing that the specimens collected by the "Tjalfe" expedition quite agreed with the description and figures of Haeckel, I referred them, unfortunately, to "*Thaumantias eschscholtzii*" without closer examination (Kramp 1913, p. 267 and 1914, p. 419).

Morphological remarks:

The base of the stomach is cross-shaped. In quite young individuals (diameter 1.5–2 mm) the mouth-lips are egg-lancet-shaped, entire, without folds (textfig. 11, from a specimen, 1.5 mm wide, from Trangisvaag at the Faeroe Islands). Later they become much folded and are besides, in large specimens, rather much lobated. There is a stomachal peduncle, very short and broad, but distinctly marked from the subumbrella. Young specimens (when about 2 mm wide) have no stomachal peduncle, the future presence of which is however indicated by a flattened area in the upper part of the subumbrella, whereas the exumbrella is evenly rounded on the top (see the diagrammatic figure, textfig. 12, drawn from a specimen, 1.8 mm wide, from Trangisvaag, Faeroe Islands).

The gonads always commence at or very near the base of the stomachal peduncle (Plate IV, figs. 9 and 10) without relation to the developmental stage of the individual. The distance from the distal end of the gonads to the circular vessel, on the other hand, depends on the developmental stage.

The female gonads are sinuous, with 2--3 bendings towards either side (textfig. 13 *a*). The male gonads are thick, cylindrical, only provided with a single constriction or bend near the middle (textfig. 13 *b*), more seldom with a couple of bends (textfig. 13 *c*). — In the gonadial part of the radial canals the gonads occupy the lateral walls from the subumbrella nearly to the ventral edge, leaving only a very narrow edge to separate the gonads of the two sides (see Plate IV, fig. 6, representing a transverse section of a radial canal with male gonads). Plate IV, figs. 7, 8, 9, and 10 represent the female gonads. It will be observed that the eggs are placed in the ectoderm in a single layer; fig. 7 is a transverse section of a canal with unripe eggs; in fig. 8 the eggs are mature, and some of them have penetrated the ectodermal epithelium; several eggs have already been detached; figs. 9 and 10 represent mature female gonads, the ripe eggs situated closely side by side on the outer surface of the lateral walls of the canal, ready for deliberation. In the gonadial part the radial canal is much compressed laterally, having a high and narrow lumen.

The size of the individuals, when the sexual products become mature, is somewhat variable. In a few cases I have found fully mature specimens being 10–12 mm wide, but as a rule the maturity does not seem to be reached until the diameter of the animal is 14–15 mm. I have seen female individuals, which have deliberated their eggs, with the following diameters: 15, 16, and 18 mm (all from Iceland).

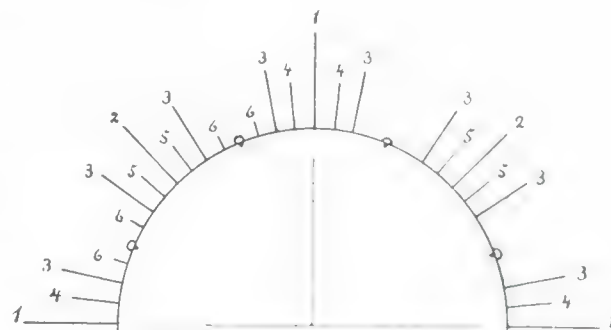


Fig. 14. *Tiaropsis multicirrata* Sars. Diagram, showing the succession in the development of the tentacles. From a specimen, 1.5 mm wide, with 47 tentacles.

The marginal vesicles and the ocelli have been examined by Böhm (1878) and Linkö (1900). The concretions are, as a rule, placed in a single bow-shaped row; not seldom, however, one or more of the concretions are pushed out from the row, so that there may even be two rows. The concretions are large, globular, or somewhat angular owing to mutual pressure. They are placed closely side by side. As a rule most of them are of equal size, only the outermost on both sides being smaller (younger); not seldom there is a very tiny concretion at one of the outer ends of the row. Accordingly the concretions seem to be formed and developed from the middle of the row outwards.

A specimen from Trangisvaag, Faeroe Islands (locality No. 20 b in the list below), 1.5 mm in diameter, has 47 tentacles, the sizes and arrangement of which clearly indicate the succession in which the tentacles are developed. The facts are represented in the diagrammatic figure, textfig. 14. The diagram agrees very well with that given by A. Agassiz (1863) for *Tiaropsis diademata*, though I am not sure, whether No. 4 and 5 may not be of the same age. The position of the marginal vesicles corresponds to that of a third series of tentacles, and possibly the marginal vesicles actually have to be regarded as being homologous with as many tentacles. Thus the formula for the first 40 tentacles in the present specimen is as follows: $4t_1 + 4t_2 (+ 8 \text{ marginal vesicles}) + 16t_3 + 8t_4 + 8t_5$, or, if t_4 and t_5 are of the same age: $4t_1 + 4t_2 (+ 8 \text{ marginal vesicles}) + 16t_3 + 16t_4$. — The tentacles are densely

crowded on the bell margin, and not seldom two successive tentacular bulbs are more or less coalesced. In the countings of tentacles, mentioned below, two such tentacles with coalesced bulbs are always counted as two tentacles. The number of tentacles in different specimens of equal size is very variable (see below). The greatest number, which I have observed, is 328, found in a specimen, 15 mm wide, from Dyrefjord, Iceland (Loc. No. 18 c).

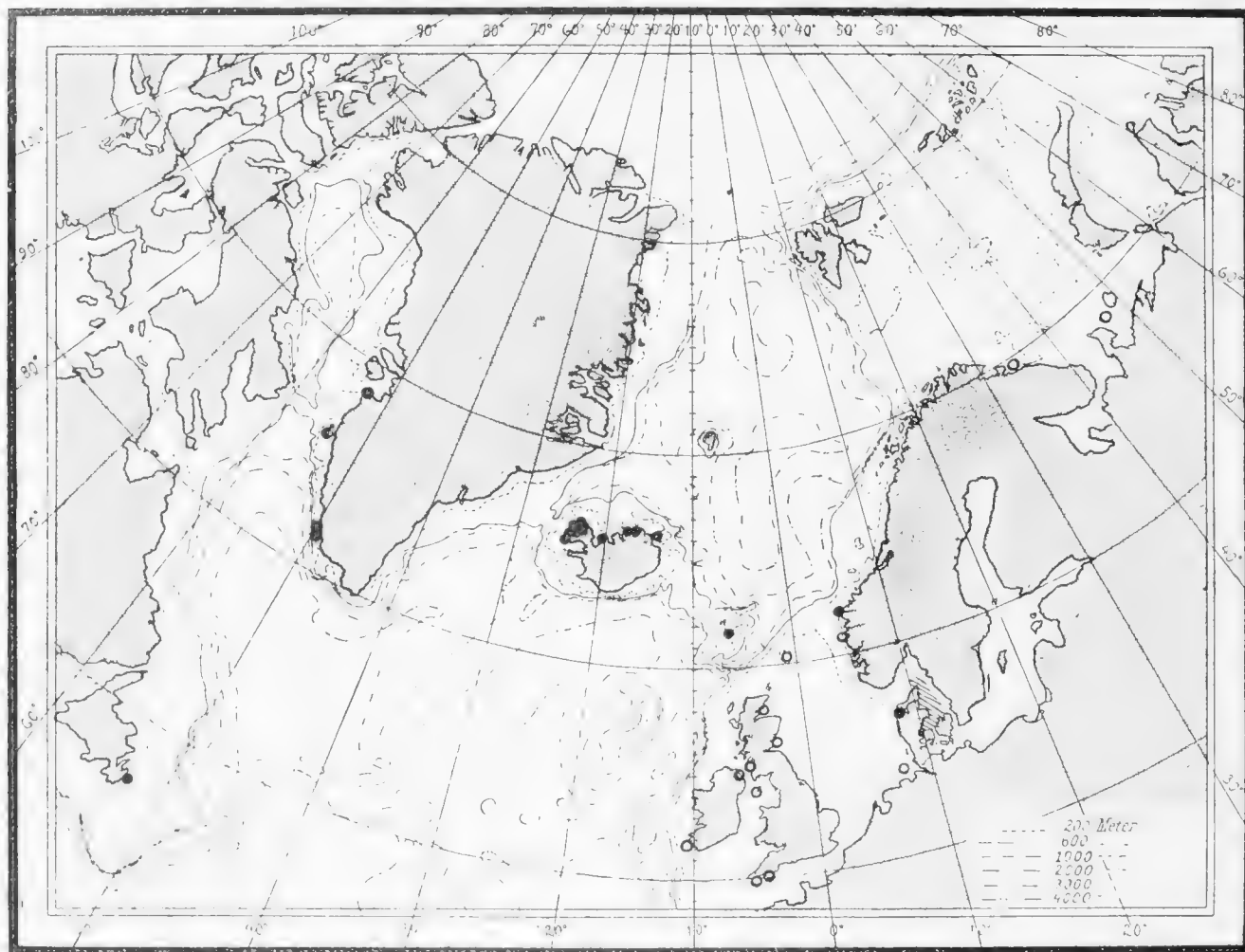


Chart X. Occurrence of *Tiaropsis multicirrata* M. Sars in the northern Atlantic and adjacent waters.

○ Occurrence according to the literature.

Material (see Chart X):

West Greenland:

- 1) — Greenland, Holbøll (1841). — 1 specimen. Type specimen of *Thaumantias eschscholtzii* Haeckel.
- 2) — Greenland (1865). — 2 specimens, labelled *Thaumantias eschscholtzii*.
- 3) — Egedesminde, Bergendal (1890). — 1 specimen.
- 4) — Lat. 66°11' N., Long. 54°27' W., off Sondre Stromfjord. August 28th 1908. Ringtrawl, 80 m wire. "Tjalle" stat. 221. — 1 specimen, 15 mm wide.

5) — South of Northern Storø near Frederikshaab. July 2nd 1909. Depth 265 m. Ringtrawl, 100 m wire. "Tjalfe" stat. 502. — 18 specimens 6—10 mm wide.

6) — Frederikshaab harbour. July 8th 1909. Surface. "Tjalfe" stat. 519. — Several hundreds of specimens, the smallest being about 6 mm wide; most of the specimens are 10—14 mm wide.

New Foundland:

7) — St. Johns. July 5th 1910. Surface. "Michael Sars" 1910. — 37 specimens, from 6 mm in diameter; most specimens are 10—12 mm wide. In Bergens Museum.

Iceland:

8) — Lat. 66°17' N., Long. 14°27' W., near Cape Langenæs. July 20th 1904. Depth 77 m. Young-fish trawl, 80 m wire. "Thor" stat. 203 (04). — 1 specimen, 13 mm wide.

9) — Axarfjord. August 12th 1903. Depth 38 m. Young-fish trawl about 1 m below the surface. "Beskytteren", Otterstrøm. — 1 specimen, 12 mm wide.

10) — Lat. 66°14' N., Long. 17°28' W., off Skjalfandifjord. July 21st 1904. Depth 200 m. "Thor" stat. 208 (04). — 14 specimens, 11—18 mm wide.

11) — Ingolfsfjord. July 13th 1902. "Diana", A. Ditlevsen. — 5 specimens, 7—13 mm wide.

12) — Hesteyrifjord. June 25th 1902. Surface. "Diana", A. Ditlevsen. — 115 specimens, 5—13 mm wide, most specimens 10—12 mm.

13) — Veidileysafjord. June 26th 1902. Surface. "Diana", A. Ditlevsen. — 6 specimens.

14) — Mouth of Hrafnarfjord. June 27th 1902. "Diana", A. Ditlevsen. — 18 specimens, 7—12 mm wide.

15) — Skutilsfjord. June 5th 1892. Lundbeck. — 9 specimens, 2—5 mm wide.

16) — Isafjord. June 6th 1895. "Ingolf". — 42 specimens, 3—9 mm wide; most specimens 3—5 mm. 24 of these specimens are treated with osmic acid.

17) — Önundarfjord. July 20th 1892. Lundbeck. — 4 specimens, 11—16 mm wide.

18) — Dyrefjord:

a. July 14th 1892. Lundbeck. — 16 specimens, 7—12 mm wide.

b. June 1st 1895. "Ingolf". — 33 specimens, 2—5 mm wide.

c. August 4th 1895. "Ingolf". — 3 specimens, 11—15 mm wide.

19) — Patreksfjord. June 22nd—23rd 1904. Surface, fished from the ship. "Thor" stat. 159 (04). 4 specimens, 10—11 mm wide.

Faeroe Islands:

20) — Trangisvaag:

a. May 3rd 1895. "Ingolf". — 2 specimens, 1.8—3.5 mm wide.

b. May 9th 1895. "Ingolf". — 2 specimens, 1.5—3.5 mm wide.

Norway:

21) — Kalvaag. June 14th 1903. "Michael Sars". — 4 specimens, 11—14 mm wide.

All specimens here mentioned, except those from loc. No. 7, are in the Zoological Museum of Copenhagen.

The investigations, mentioned below, are based on this material and, besides, on material from the Danish waters, *viz.* from: Næs Sound in the Limfjord; north of the Hirtsholme; Frederikshavn; Læso Channel; Snoghoj in Lillebelt.

As will be seen from the list above, I have had at my disposal for investigation abundance of material from the following regions: New Foundland, West Greenland, Iceland, the Faeroe Islands, Norway, and Denmark. It was reasonable, therefore, to make use of this material in order to examine, whether the European and the American form are to be regarded as distinct species or merely varieties of one and the same species, or whether there might, possibly, prove to be no traceable difference whatever between the two forms.

With regard to the shape and size of the manubrium, the length and position of the gonads, and the shape of the tentacular bulbs, I have been unable to find any differences.

According to the literature, the pigmentation of the tentacular bulbs has been estimated as establishing the main difference between *Tiaropsis diademata* and *multicirrata*. Mayer (1910, pp. 258 and 259) expresses the difference in the following way: *Tiaropsis diademata*: "Entoderm of tentacle-bulbs and of stomach ocher-yellow. Gonads are cream-colored". *Tiaropsis multicirrata*: "... distinguished from the American *T. diademata* by the black entodermal pigment of its tentacle-bulbs". "Entoderm of gonads, stomach, and bell-margin dull-yellow. Ocelli and pigment of tentacle-bulbs black." — Bigelow (1913, p. 32) states as follows with regard to *Tiaropsis diademata*: "The fact that *diademata* lacks tentacular ocelli has been established on great numbers of specimens, but the tentacular bulbs are not altogether without pigment, for in all the numerous specimens which I have studied they contain a small amount of entodermic pigment of a pale greenish or yellowish-brown color", and with regard to *multicirrata* that, according to the figures at hand, they have "the same entodermic pigment, only in much denser masses, and black instead of pale greenish". With regard to the specimens from the northern Pacific, examined by him, Bigelow states as follows (p. 33): "the entoderm of each bulb contains pale greenish, or in some cases greenish-brown, pigment, in a roughly triangular mass"; this pigment is denser than that, which the author has observed in Atlantic specimens of *diademata*, but never black as in *multicirrata*. In a footnote (p. 33) he states that in some specimens from Massachusetts Bay "the tentacular bulbs were densely pigmented with black granules, thus exactly reproducing the European type". These "black granules" probably means the ectodermal pigment granules, which I have likewise found in specimens from both sides of the Atlantic, and which must be well distinguished from the entodermal pigment.

There can be no doubt, but that the pigment may disappear to a greater or lesser extent owing to the preservation. I have seen specimens from Greenland, Iceland, the Faeroe Islands, Norway, and Denmark, preferably when preserved in alcohol, which have retained no other pigment than that of the 8 large ocelli at the marginal vesicles. In better preserved specimens, particularly when preserved in formalin, from New Foundland, Greenland, Iceland, and Denmark, fine black granules are nearly always found on the surface of the marginal vesicles and the nematocyst-bearing pads of the tentacular bulbs, i. e. on the adaxial and lateral sides of the bulbs. After clearing in xylol and under high power this pigment appears to consist of accumulations of fine, black granules. Once I conceived

the suspicion that these granules might possibly not be pigment, but foreign matters (dirt, particles of china-ink from the labels). Their mode of distribution, however, contradicts such an apprehension, as they are only found in the said places, *viz.* on the nematocyst-pads and on the surface of the marginal vesicles; they are wanting on the bulbs of younger tentacles. Similar dark pigment granules may also be found on the surface of the gonads. In the angle between the gonads and the subumbrella unquestionable particles of dirt of quite another appearance are frequently observed.

It is not always easy to detect the entodermal pigment mass in the tentacular bulbs, and in several cases, when a number of specimens were at hand from one and the same locality, I have been able to find the pigment masses in some specimens but not in others. It is only to be observed when placed above a white support and when lighted from above; it then appears as a triangular mass; as a rule it stands out most distinctly when seen from the adaxial side. Frequently the colour is indeterminable, but in other cases the colour has been very clear and distinct. As mentioned above Bigelow has found the entodermal pigment in the bulbs of American specimens being pale greenish or yellowish-brown. In the specimens, examined by me, from St. Johns, Newfoundland (Loc. 7) the entodermal pigment is yellowish-brown, mostly very clearly visible. In specimens from Greenland, Iceland, and Denmark I have found the same yellowish-brown colour and, frequently, also a distinct green colour in the entoderm of the tentacular bulbs; black entodermal pigment I have never seen.

It appears, accordingly, that the *Tiaropsis* from the whole of the North-Atlantic area from the Danish coasts through the waters round Iceland and Greenland to North-America and from the northern Pacific agree completely with regard to the ectodermal as well as the entodermal pigmentation, and thus the character, which has been considered to be the only important feature separating the two "species", does not hold good.

There can be no doubt, accordingly, but that the European and the American *Tiaropsis* belong to the same species. Still the question may arise, whether there might exist a difference between the specimens from the different regions with regard to the size of the bell, the number and arrangement of the tentacles, and other measurable characters. Regarding this question I have measured the diameter and counted the tentacles in a large number of specimens, in so far as they are sufficiently well-preserved for such purpose. I have found that within each of the areas in question there appears a considerable variation concerning these characters, but that the average figures for the various areas are so near each other, that we can hardly speak about local varieties. As the investigation may possibly have some importance from a variation-statistical point of view, I am going to give a short account of the results.

One of the characters I wanted to examine, was the relation between the number of tentacles and the diameter of the bell. It is evident that measurements of preserved medusæ have to be used with caution, because the individuals always contract at the preservation and not always to the same degree. The figures in the tables (IX and X), representing the diameter, must therefore be used with reservation, but they seem to indicate that the specimens from the different areas agree in the main with regard to the said feature.

In table IX is represented the correlation between the number of tentacles and the diameter of the bell of specimens from the different regions; the general results of the table have been gathered

Table IX. Variation of *Tiaropsis multicirrata*.Correlation between the number of tentacles and 1) the diameter of the specimens, 2) the quantity $\frac{p}{i}$.

Denmark.

Number of tentacles, about	Diameter of specimens, mm																Total	Average diameter, mm	$\frac{p}{i}$								Total	Average of $\frac{p}{i}$
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	0.8			0.9	1.0	1.1	1.2	1.3	1.4	1.5			
150	.	.	2	1	1	.	.	1	3	.	1	.	.	.	.	9	7.8	1	1	.	3	1	1	1	1	9	1.02	
200	.	.	.	3	1	2	1	2	3	7	12	6	1	2	1	41	11.0	.	8	11	16	4	2	.	.	41	1.05	
250	.	.	.	.	.	.	1	.	3	.	.	3	2	2	.	11	12.3	.	.	4	.	3	4	.	.	11	1.16	
Total number	2		4	2	2	2	3	9	7	13	9	3	4	1	61	1		9	15	19	8	7	1	1	61	1.09 $\pm$ 0.14		

Faeroe Islands and Norway.

50	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2.0	.	1	.	1	.	.	.	.	2	1.00
100	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
150	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	4.0	.	.	.	.	.	.	1	.	1	1.40
200	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	11.0	.	.	.	.	.	.	.	.	.	.
250	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	3	14.0	.	.	.	1	.	.	.	.	1	1.10
Total number of specimens }	2	.	1	.	.	.	.	.	.	1	.	.	3	.	.	7		.	1	.	2	.	.	1	.	4	1.125 $\pm$ 0.18

Iceland.

50	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2.0	.	.	.	1	.	.	.	.	1	1.10
100	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	3	2.3	.	.	.	1	1	1	.	.	3	1.20
150	.	.	2	.	1	2	.	.	.	.	.	.	.	.	.	5	5.6	1	.	1	1	.	1	1	.	5	1.12
200	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	2	8.5	.	1	1	.	.	.	.	.	2	0.95
250	.	.	.	.	.	1	.	1	1	2	1	1	.	1	1	9	11.6	.	1	.	2	2	1	1	1	8	1.21
300	.	.	.	.	.	.	.	.	.	.	1	2	.	.	.	3	12.7	.	.	.	1	1	1	.	.	3	1.20
350	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	15.0	.	.	.	1	.	.	.	.	1	1.10
Total number of specimens }	3	1	2	.	1	4	.	1	2	2	2	3	.	2	1	24		1	2	2	7	4	4	2	1	23	1.16 $\pm$ 0.17

Greenland.

100	.	.	.	I	I	I	.	.	.	.	.	.	.	.	3	6.0	.	.	.	.	.	.	.	.	.	.	.	...
150	.	.	.	.	.	2	.	.	.	.	.	.	.	.	2	7.0	I	.	I	.	.	.	.	.	.	2	0.90	
200	.	.	.	.	.	.	.	.	I	I	.	.	I	.	3	11.7	.	I	2	.	.	.	.	.	3	0.97		
250	.	.	.	.	.	.	.	.	.	.	I	.	2	I	.	4	13.8	.	2	I	.	I	.	.	.	4	1.00	
Total number of specimens }	.	.	.	I	I	3	.	.	I	I	I	.	3	I	.	12		1	3	4	.	I	.	.	.	9	0.97 $\pm$ 0.11	

New Foundland.

200	.	.	.	.	2	1	1	2	.	.	.	.	.	.	.	6	7.5	.	2	3	1	.	.	.	.	6	0.98
250	.	.	.	.	.	.	.	1	3	3	4	.	.	.	.	11	10.9	2	2	3	3	1	.	.	.	11	0.99
300	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	3	12.0	1	.	.	2	.	.	.	.	3	1.00
Total number of specimens }	.	.	.	.	2	1	1	3	3	3	7	.	.	.	.	20		3	4	6	6	1	.	.	.	20	0.99 $\pm$ 0.11

Table X. Synopsis of the Results, obtained from Table IX.

Number of tentacles, about	Average diameter, mm				
	Denmark	Faeroe Islands and Norway	Iceland	Greenland	New Foundland
50.....	...	2.0	2.0		
100.....	..	...	2.3	6.0	
150.....	7.8	4.0	5.6	7.0	
200.....	11.0	11.0	8.5	11.7	7.5
250.....	12.3	14.0	11.6	13.8	10.9
300.....	...	...	12.7	..	12.0
350.....	...	...	15.0		
Number of specimens examined..	61	7	24	12	20
	Values of $\frac{p}{i}$				
Lowest value of $\frac{p}{i}$	0.82	0.85	0.81	0.75	0.78
Highest — — —.....	1.50	1.40	1.54	1.22	1.22
Average — — —.....	1.09	1.12	1.16	0.97	0.99
Standard deviation.....	± 0.14	± 0.18	± 0.17	± 0.11	± 0.11
Number of specimens examined..	61	4	23	9	20

in table X. The columns of this table give the average diameter of specimens with so and so many tentacles. The differences between the figures for the various regions are not larger, but that they may be due to casual variation and different degree of contraction. This is most obviously seen, when the figures are represented by curves, one curve representing the results for each of the areas (textfig. 14). The 5 curves cut each other in a quite irregular manner in different points, at the same time as their courses are mainly alike.

A feature, which may be characterised by means of mere countings, being independent on contraction or other phenomena produced by preservation, is the situation of the marginal vesicles in relation to the tentacles. A numeral expression of this situation may be attained in the following manner. In each individual we count the number of tentacles situated between the two marginal vesicles of one and the same quadrant (i. e. around the interradians of the animal), and the number of tentacles between the two marginal vesicles situated on either side of one and the same radial canal (i. e. around the perradians of the animal). When one of the figures found is divided by the other, we obtain a numeral expression of the place of the marginal vesicles in the specimen in question. For the sake of brevity I use the letter i to represent the number of tentacles in the interradian spaces between the marginal vesicles, whereas the letter p represents the number of tentacles in the perradian spaces. Then I operate with the quantity $\frac{p}{i}$. This quantity appears to be highly variable. One should expect it to keep tolerably near 1, but as will be seen from the table, the value may vary between about 0.8 and 1.5 within one and the same locality. It will be seen from table IX that there is no correlation between $\frac{p}{i}$ and the absolute total number of tentacles. Table X gives the average value of $\frac{p}{i}$ within each of the geographical regions, the standard deviation, and the lowest and highest

values found. According to the table a difference between the East- and West-Atlantic specimens seems actually to exist with regard to the quantity $\frac{p}{t}$, in so far as the average value as well as the extremes of the series of variation are distinctly lower as far as the specimens from the two western areas are concerned than in the case of the specimens from the three eastern areas. That means that the marginal vesicles are placed somewhat nearer to the radial canals in the specimens from the western

Atlantic than in the specimens from the eastern Atlantic area. The standard deviations are, however, so large that we cannot state at present, whether this result rests on a real fact or whether it is merely casual.

Distribution and Occurrence.

Tiaropsis multicirrata has a fairly wide distribution in the North-Atlantic area. Its occurrence is distinctly neritic.

It is very common at the Atlantic coast of North-America from Eastport to Cape Cod (L. Agassiz 1849, A. Agassiz 1865, Bigelow 1912, 1914a, 1915). Within that region it occurs during the spring from March to May or the beginning of June. It is met with only occasionally south of Cape Cod, penetrating as far as Woods Hole (Nutting 1901, Hargitt 1902 and 1904).

At the west coast of Greenland *Tiaropsis multicirrata* has been found on several localities near the shore (see chart X), as far northwards as Egedesminde (loc. 3). With regard to the occurrence on loc. 4, 5, and 6 (the stations of the "Tjalfe" expedition) I shall make the following remarks: On stat. 221 (loc. 4), August 28th 1908, a specimen was

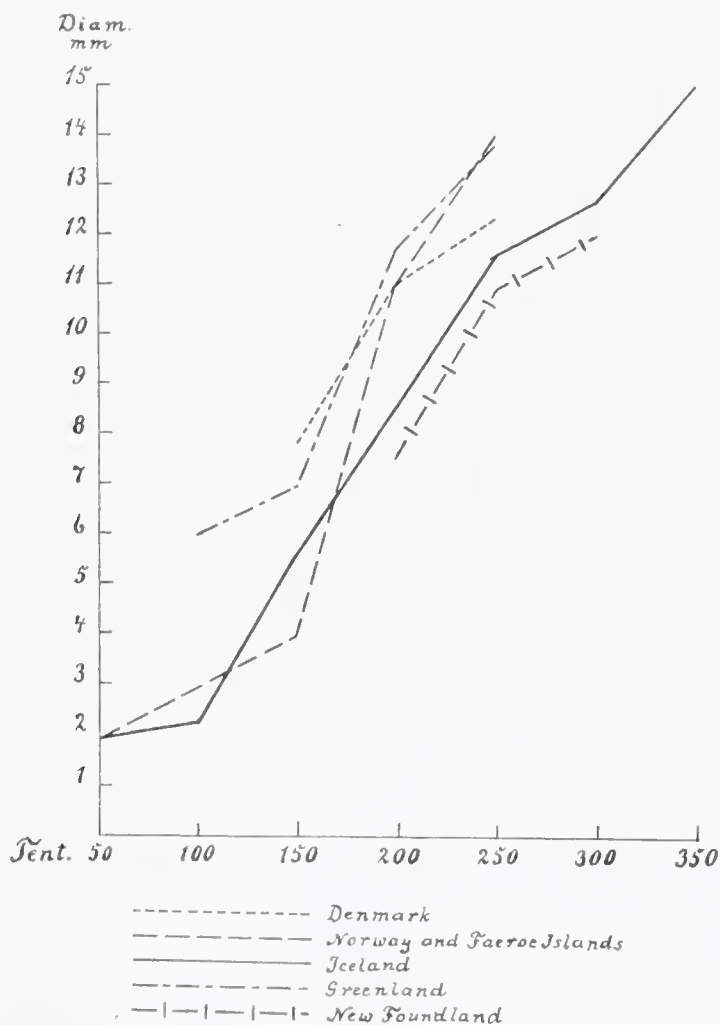


Fig. 15. *Tiaropsis multicirrata* Sars. Curves showing correlation between the diameter of the specimens and the number of tentacles within different geographical areas.

taken about 50 m below the surface; in an adjacent place the temperature of the water was found to be evenly decreasing from 4°.78 at the surface to 0°.63 near the bottom (128 m); about 50 m below the surface the temperature was about 2°, the salinity about 33 ‰. In 1909 the species was found on July 2nd and 8th very near the shore in the neighbourhood of Frederikshaab (stat. 509 and 519), at both occasions in large numbers and in water of low, though positive temperature. On stat. 509 (depth 265 m) 18 specimens were found about 60–65 m below the surface; the temperature was: in 50 m 0°.42, in 75 m 0°.14, the salinity was 32.5–33 ‰. On stat. 519 (depth 406 m) several hundreds of specimens were taken at the surface at a temperature of 0°.83; in 10 m depth the temperature was ÷ 0°.10,

whence it was slowly increasing towards the bottom. — The occurrence of *Tiaropsis multicirrata* in the Greenland waters must, probably, be regarded from the point of view, that the species is strictly neritic and, therefore, does not occur in the Atlantic water-masses in the deep parts of the Davis Strait, being restricted to the coastal regions where the water is very cold during the main part of the year, except in the deeper strata in certain fjords. Not until rather late in the summer, when the effects of the Polar Current are comparatively slight, and the surface of the sea is lighted by the sun during the greater part of the twenty-four hours, the upper water layers attain a tolerably high temperature. In agreement herewith *Tiaropsis*, which disappears from the coasts of New England as early as in May, occurs at the Greenland coasts in the middle of the summer. Most of the individuals found are large, mature or near maturity; probably the young specimens live in the deeper, warmer strata in the fjords earlier in the summer. The fact that the species occurs in this area in the warmest part of the summer, while in other regions it is found in the spring, and the fact that it has not hitherto been found in water of negative temperature, agree very well with our knowledge of the occurrence of the species in other regions, *viz.* that it is a boreal species and avoids warm as well as ice-cold water.

Tiaropsis multicirrata has a fairly wide distribution at the coasts of the British Isles, but nowhere it seems to occur in any great abundance. It has been found at the Shetland Islands ("*Thaumantias melanops*", Forbes), in Cromarty Firth ("*Tiaropsis oligoplocama*", Romanes), west-coast of Scotland, Port Erin, Belfast on Ireland ("*Thaumantias pattersonii*" Greene), Valencia Harbour, Falmouth, and Plymouth; in the southern of those places it has only been found occasionally. — The data regarding the seasons of the finds demonstrate that the species appears at the British coasts in the early spring, at the end of March, and disappears in May, seldom as late as in June. Browne (1895, 1900, 1905 a) has found quite young specimens at the end of March and in April in Firth of Clyde, at Port Erin, and at Valencia Harbour.

Tiaropsis multicirrata has been found at Heligoland by Böhm (1878, p. 184, in great abundance in April, never in the summer) and by Hartlaub (1894, p. 192, from March 3rd to April 12th, being most common at the end of March).

It seems to be a regular visitor to the Danish waters in the spring; it has frequently been found in the northern part of the Kattegat, and in May 1915 I found some few specimens in Lillebelt. The Danish finds are altogether from the end of April and the first half-part of May; large specimens have been taken in the middle of May.

We know very little about the distribution of *Tiaropsis multicirrata* along the coast of Norway. M. Sars (1835) found it in the neighbourhood of Bergen; moreover it has been found at Kalvaag south of Stat in June 1903 (loc. 3, also mentioned by Broch 1905, p. 7).

It occurs in the Barents Sea (Linko 1900 and 1904 b), most commonly in the eastern part between Kanin and Kolguev Island; in the western part of the Barents Sea it is met with only occasionally.

Near Trangisvaag on the Faeroe Islands some few specimens were found by the "Ingolf" expedition at the beginning of May 1895 (loc. 20).

The occurrence at the coasts of Iceland is peculiar. As will appear from the above list of localities, *Tiaropsis multicirrata* has been found on several Icelandic localities, all of which are on the

north coast or in the fjords of the north-western part of the country. As the species lives at the British, Norwegian, and Danish coasts, one should also expect it to occur at the southern and western coasts of Iceland and not to be restricted to the north coast, where the water is distinctly colder. By a more thorough examination of the facts we may, however, find a natural, though hypothetical, explanation of the fact here mentioned. First we must pay attention to the currents around the Icelandic coasts. The northern branch of the Gulf Stream runs towards the south coast of Iceland and turns in a westerly direction (the Irminger Current), running towards the west along the south coast, towards the north along the west coast, and towards the east along the north coast, its power and effects gradually decreasing. The Polar Current, coming from the Polar Sea, strikes the north-east point of Iceland (Cape Langenæs) and divides into two branches; the left branch runs towards the south along the east coast of Iceland, meeting the above mentioned northern branch of the Gulf Stream over the Wyville Thomson ridge; thereby the warm current is forced towards the west, the cold current towards the east; there may be an extraordinarily sharp limit between the warm and the cold water near the island Papey on the south-east coast of Iceland. The right branch of the Polar Current bends towards the west, but meets the comparatively warm coastal current and is forced, therefore, to run in some distance from the coast in a direction towards the east coast of Greenland, where it unites with the East-Greenland Polar Current. The distance of the cold water from the north coast of Iceland varies very much according to the season and other circumstances, but during the summer the warm current has usually so much power that the coastal water is comparatively warm all along the north coast as far as Langenæs. There is nothing particular, therefore, in the boreal species *Tiaropsis multicirrata* being able to live in the fjords of the northern coasts of Iceland, and it is quite natural that the species is entirely wanting on the cold east coast; but why has it never been found at the west and south coasts? Now we must remember that in the British and adjacent waters the species has its occurrence in the spring, the young medusæ appearing in March—April, reaching maturity in May. Undoubtedly young *Tiaropsis* might also be found at the south and west coast of Iceland in the spring months, but no collections have been made in Icelandic waters during that season. My hypothesis is, that the medusæ which are deliberated on the south and west coast are carried along by the coastal current to the north coast, where they come at rest in the numerous fjords together with individuals, hatched and developed on the spot; thus the want of material of the species from the south and west coast is due partly to want of collections from the spring time, partly to the comparatively strong current running along these coasts. The finds from the northern coasts of Iceland have been made between June 1st and August 12th. There are a number of young specimens, 2—9 mm wide, from the first days of June, whereas larger individuals have been found during the later half-part of June, and mature specimens at the end of June, during July, and at the beginning of August.

The specimens, mentioned by Bigelow, from the northern Pacific (Dutch Harbour and Agattu Island) were found on May 25th and June 7th; they were altogether well-sized individuals.

We may then state as a general result that *Tiaropsis multicirrata* is a neritic-boreal species, living in the boreal coastal regions in the North Atlantic area and in the northern Pacific. In the greater part of the area of distribution its occurrence is limited to the spring months, the young specimens appearing in March, growing to maturity in May, and disappearing in May or June. In the

waters of Iceland and Greenland the season of its appearance falls somewhat later, in accordance with the later commencement of the spring. Young specimens may be found at the northern coasts of Iceland as late as in June, and at Iceland as well as at the west coast of Greenland full-grown specimens may still be met with in August.

Family Eucopidæ Gegenbaur.

Genus *Obelia* Péron et Lesueur.

Three species of the hydroid genus *Laomedea* producing free-swimming medusæ (*Obelia*) occur in the North Atlantic area, viz. *Laomedea geniculata*, *dichotoma*, and *longissima*, all of which are very widely distributed. Several authors have tried to find characters serviceable for separation of the medusæ of these species, but up to now the results have been very poor. The question has especially been dealt with by Browne. In 1900 he described a new species, *Obelia nigra*, easily recognizable on account of some of the tentacular bulbs (about 6 in each quadrant in full-grown medusæ) being double the size of the others and provided with dark pigment. Browne is now of the opinion that *Obelia nigra* is the medusa of *Laomedea longissima*. Browne has succeeded in rearing the medusæ of the two other species and keeping them alive in aquaria for a considerable time, but he has told me that there is no traceable difference between the medusæ of the two species. I myself has likewise tried to rear the medusæ of the three species of *Obelia* during a stay in Plymouth in 1914. I think that I have found certain characteristical differences between the species in the early stages, but I was not able to make the specimens grow very much in the aquaria, evidently because I did not give them the right kind of food. Later on, in 1916, I have tried to keep *Obelia geniculata* in plunger-aquaria in the laboratory for zoo-physiology in Copenhagen, but here the question of food-supply was still more difficult. Some of the specimens lived in the aquaria for several weeks, but they did not increase in size. I have, however, not yet relinquished all hope but that I shall succeed sometimes in solving the problem of the difference between the three species, but for the present we must leave the matter in abeyance.

In the following I shall give a list of the North-Atlantic material of *Obelia* at my disposal, first recording the specimens which may be referred with certainty to *Obelia nigra*, and then the others which may not at present be specifically identified.

Obelia nigra Browne.

Obelia nigra Browne 1900. Fauna and Flora of Valencia Harbour. — Proceed. Roy. Irish Acad. Ser. 3. Vol. V. — p. 721.

Material:

Iceland:

- 1) — Lat. 66°17' N., Long. 14°27' W., near Cape Langenes. July 20th 1904. Depth 77 m. Young-fish trawl, 80 m wire. "Thor" stat. 203 (04). — 2 specimens.
- 2) — Ingolfssjörd. July 12th 1902. "Diana", A. Ditlevsen. — 8 specimens, partly very large.
- 3) — Hesteyrifjörd. June 25th 1902. Surface. "Diana", Ditlevsen. — 9 specimens.

- 4) — Veidileysafjord. June 26th 1902. Surface. "Diana", Ditlevsen. — 32 specimens.
- 5) — Mouth of Hrafnafjord. June 27th 1902. Vertical haul. "Diana", Ditlevsen. — 10 specimens.
- 6) — Dyrefjord. June 3rd and 6th 1895. "Ingolf". — 5 specimens.

Faeroe Islands:

- 7) — Kvannesund. May 26th 1902. Surface. "Diana", Ditlevsen. — 37 specimens.
- 8) — Sorvaag. May 13th 1902. Surface. "Diana", Ditlevsen. — 1 specimen.
- 9) — Trangisvaag. May 3rd 1895. "Ingolf". — 3 specimens.

British Isles:

- 10) — Lat. 59°00' N., Long. 3°34' W., at the Orkney Islands. May 21st 1908. Depth 66 m. Surface. "Thor" stat. 2 (08). — 2 specimens.
- 11) — Lat. 57°36' N., Long. 7°05' W., Little Minch, west of Scotland. May 27th 1908. Depth 90 m. Young-fish trawl, 65 m wire. "Thor" stat. 8 (08). — 12 specimens.

The medusa *Obelia nigra* is previously known from the British Isles (Plymouth, Valencia Harbour, Port Erin, Firth of Clyde, according to Browne 1900, p. 721 and 1905 a, p. 770; M. & C. Delap 1905, p. 12), and from different localities at the Norwegian coast (Browne 1903, p. 16; Broch 1905, p. 7). Moreover it is very common in the Danish waters.

Obelia spp.

Material:

Greenland. Bergendal. — 2 specimens.

Iceland:

Hesteyrifjord. June 25th 1902. Surface. "Diana", Ditlevsen. — 2 specimens.

Skutilsfjord. June 5th 1892. Lundbeck. — 4 specimens.

Dyrefjord. May 30th—June 3rd 1895. "Ingolf". — Altogether 24 specimens, partly treated with osmic acid; some of these specimens probably belong to *Obelia nigra*.

Danmark Strait, near Snefjeldsjokel on Iceland. June 11th 1895. "Ingolf". — 1 specimen.

Agastra mira Hartlaub.

Mayer 1910, Medusæ of the World, p. 234.

Bell somewhat higher than wide, 1 mm high; gelatinous substance quite thick, with a deep, funnel-shaped depression at the apex. No stomach. 4 narrow radial canals. Gonads irregularly lobated, sack-shaped evaginations on the middle part of the radial canals. The eggs become mature in the entoderm. No tentacles, but 4 minute, pigmented bulbs. Colour of bulbs, gonads, and canals dark-brown. — Abortive medusa of the hydroid *Campanularia integra* Mc Gillivray (syn. *C. caliculata* Hincks).

The medusa has been found in Valencia Harbour, Ireland, and at Heligoland.

Eucope globosa (Forbes).

Mayer 1910, Medusæ of the World, p. 235.

Bell thick-walled, slightly higher than a hemisphere, about 13 mm wide. Manubrium short, with 4 simple, recurved lips. 4 short, linear gonads, extending from the middle point of the 4 slender radial canals outwards towards the circular

vessel. About 32 fairly long tentacles. 8 marginal vesicles, each containing 3-4 or more concretions. Velum well developed. Manubrium, gonads, and tentacular bulbs yellowish or reddish-brown.

This diagnosis is based on specimens, examined by me at Plymouth, and it differs in certain regards from that given by Mayer.

The corresponding hydroid is *Campanulina repens* Hincks.

The medusa is common off the coasts of Great Britain and Holland.

Genus *Phialidium* Leuckart.

Phialidium hemisphæricum (Gronovius).

Plate IV, fig. 14; Plate V, fig. 3. Textfigs. 16 and 17.

Medusa hemisphærica Gronovius 1760. Observationes de animalculis . . . Acta Helvetica. Vol. IV. — p. 35.

Thaumantias hemisphærica Forbes 1848. British Naked-eyed Medusæ. — p. 49.

i. p. *Phialidium variabile* Haeckel 1879. System der Medusen. — p. 186.

Phialidium temporarium Browne 1896. On British Hydroids and Medusæ. — Proceed. Zool. Soc. London. — p. 489. Plate XVII, figs. 4, 5, 6.

— *hemisphæricum* Mayer 1910. Medusæ of the World. — p. 266.

For further synonymy, see Browne 1896 and Mayer 1910.

Bell nearly hemispherical, 20–25 mm wide; gelatinous substance thin. Manubrium small, with 4 simple lips. 4 slender radial canals. Gonads oval or linear, their length very much varying; they are placed along the radial canals, somewhat nearer to the circular vessel than to the manubrium. 30–58 long tentacles with somewhat swollen basal bulbs. Usually 2 marginal vesicles between every successive pair of tentacles, each vesicle containing one concretion. Velum fairly narrow. Stomach, gonads, and tentacular bulbs yellowish-brown or reddish-brown.

Among the numerous species of *Phialidium* described, two species are recorded as occurring in the North-Atlantic area, viz. *Phialidium hemisphæricum* (Gronovius), about 20 mm in diameter, with up to 39 tentacles (according to Browne; as to the Icelandic specimens, see below), usually with 2 marginal vesicles between every successive pair of tentacles, and with linear, elongate gonads on the outer halves of the radial canals; and *Phialidium buskianum* (Gosse) Browne, up to 6 mm in diameter, with 20–32 tentacles, with one, sometimes 2, marginal vesicles between every successive pair of tentacles, and with short, oval gonads between the middle of the radial canals and the circular vessel.

I am very much inclined to think that these two species cannot be kept apart. But the North-Atlantic material at my disposal cannot serve as foundation for a discussion of the matter. The Zoological Museum of Copenhagen possesses, however, a very large material of *Phialidium* from the Danish waters and, moreover, a great many specimens, which I brought home from Plymouth in 1914. I consider it most convenient, therefore, to postpone a thorough discussion of the variation of *Phialidium* and the question of the limitation of the species, until that material has been further examined. In the present paper I shall restrict myself to give some information concerning the present material.

Material (see Chart XI):

Iceland:

- 1) — South of the Myrdalsjökul. August 17th 1903. "Michael Sars". — 9 specimens, 8—16 mm wide.
- 2) — Myri Bugt. July 27th 1904. "Beskytteren", Gemzoe. — 6 large specimens.
- 3) — Lat. $64^{\circ}04' N$, Long. $15^{\circ}48' W$, Myri Bugt. July 24th 1904. Depth 49 m. Young-fish trawl about 28 m below the surface. "Beskytteren", Gemzoe. — 20 specimens, one of which is 7 mm wide, while the others are 13—25 mm.

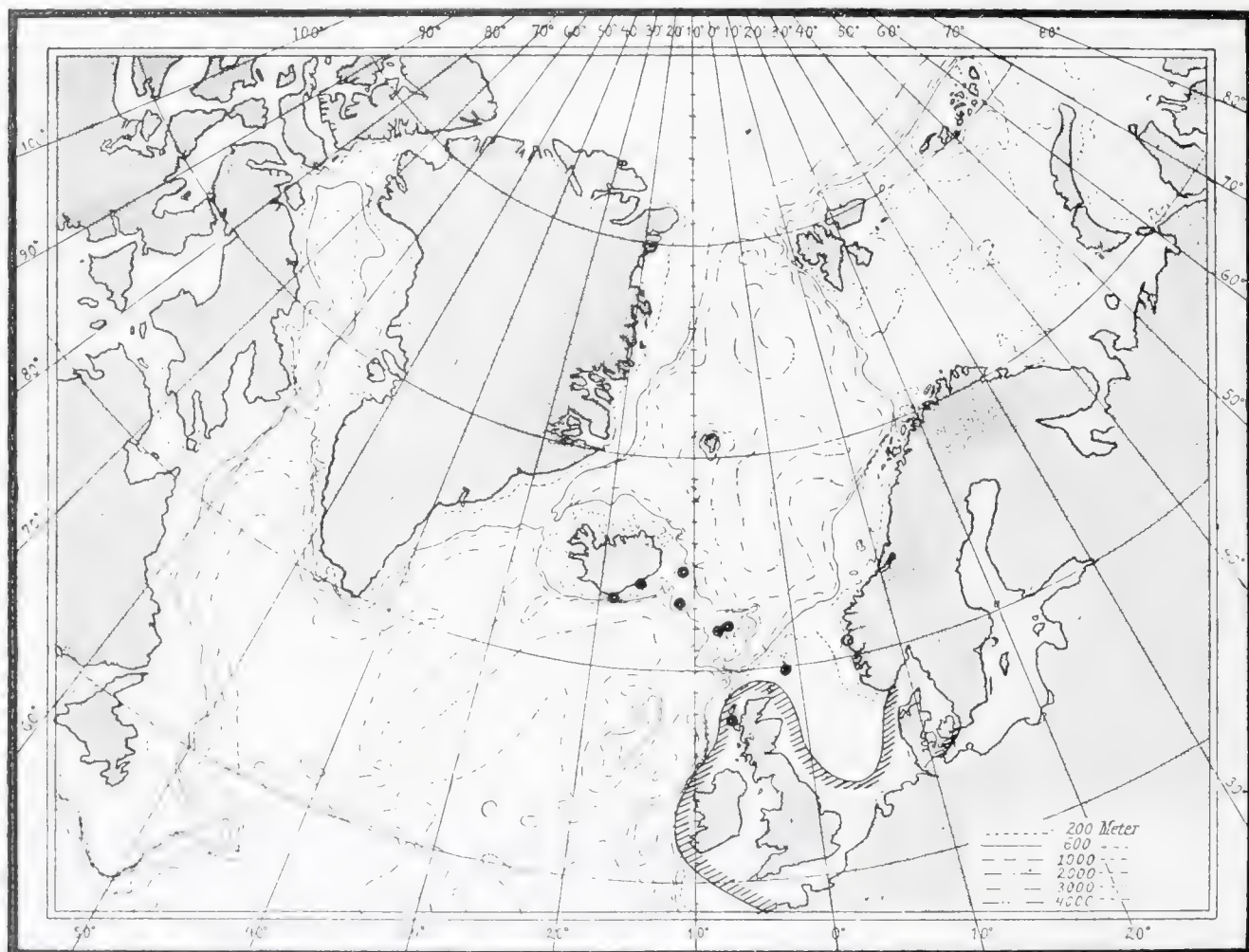


Chart XI. Occurrence of *Phialidium hemisphaericum* (Gronov.) in the northern Atlantic and adjacent waters. — From the regions within the hatched line the literature notes a common occurrence.

- 4) — Lat. $63^{\circ}12' N$, Long. $11^{\circ}45' W$, south-east of Iceland. August 7th 1904. Young-fish trawl, 20 m wire. "Thor". — 7 specimens, 15—20 mm wide.
- 5) — Lat. $64^{\circ}35' N$, Long. $11^{\circ}45' W$, east of Iceland. August 8th 1904. Depth 348 m. Young-fish trawl, 20 or 70 m wire. "Thor" stat. 241 (04). — 2 specimens, 19 mm wide.

The Faeroe Islands:

- Thorshavn. August 18th 1895. "Ingolf". — 6 specimens, 1—10 mm wide (see below).

7) — Lat. $61^{\circ}47'$ N., Long. $7^{\circ}29'$ W., west of the Faeroe Islands. August 15th 1895. "Ingolf". 2 specimens, one of which is 10 mm wide with 32 tentacles; the gonads (female) are short and thick.

British Isles:

8) — Lat. $59^{\circ}48'$ N., Long. $1^{\circ}23'$ W., south end of the Shetland Islands. July 22nd 1905. Depth 85 m. "Thor" stat. 122 (05). — 2 specimens, one large and one middle-sized.

9) — Lat. $57^{\circ}36'$ N., Long. $7^{\circ}05'$ W., Little Minch, west of Scotland. May 27th 1908. Depth 90 m. Young-fish trawl, 65 m wire. "Thor" stat. 8 (08). — 2 specimens, the largest of which is 10 mm wide with mature female gonads, 3 mm long.

The largest specimens, found by Browne at the British coasts, were 21 mm in diameter and had 39 tentacles. Among the specimens from Iceland here mentioned several appear to be of more considerable size (up to 25 mm) and, particularly, to possess a larger number of tentacles (up to 58). In all other regards the specimens agree completely with the British *Phialidium hemisphericum*, so that I do not hesitate to refer them to the same species. It seems quite natural that this species might be found off the southern coasts of Iceland, where the hydroid *Campanularia johnstoni*¹ is fairly common (according to Sæmundsson 1911 and Broch 1918).

The fully expanded tentacles are 2–3 times as long as the diameter of the bell (according to my observations from Plymouth). The tentacular bulbs are fairly broad, spherical, owing to the high development of the ectoderm on the lateral sides of the bulb. The ectoderm is likewise fairly highly developed on the adaxial side (Plate V, fig. 3). The lumen of the bulb is actually somewhat laterally compressed. — Plate IV, fig. 14 shows a section through a marginal vesicle of this species. The marginal vesicle is spherical, half-way inserted on the margin of the bell. There is, as a rule, 2 marginal vesicles between every successive pair of tentacles, though in younger specimens there is usually but one; in large specimens there are not seldom 3 marginal vesicles between two successive tentacles.

In specimens from Iceland the number of tentacles may amount to 58 (this number has been found in 3 specimens). Table XI presents a tabular view of the number of tentacles in 29 Icelandic specimens of different sizes. The calculation of the average numbers of tentacles is based on the exact

Table XI. Number of tentacles in specimens of different sizes of
Phialidium hemisphericum from Iceland.

Diameter of individuals, mm	Number of tentacles								Total	Average
	25	26–30	31–35	36–40	41–45	46–50	51–55	56–58		
6–10	1	.	3	.	.	.	.	.	4	30
11–15	.	.	1	2	1	1	.	.	5	40
16–20	.	.	.	4	1	2	3	3	13	48
21–25	.	.	.	.	.	4	2	1	7	5
Total...	1	.	4	6	2	7	5	4	29 specimens	

¹ During my stay at Plymouth in 1914 I confirmed the observation of Browne, that *Campanularia johnstoni* is the hydroid corresponding to *Phialidium hemisphericum*.

figures found by the measurements. — It will be observed that the number of tentacles varies fairly considerably within one and the same group of size; thus in specimens, 16–20 mm wide, there may be 38–58 tentacles.

Each of the radial canals carries only one gonad, completely encircling the canal without leaving a ventral edge free. This will be seen from the textfigures 16 and 17, representing transversal sections of male and female gonads. The section of the female gonad shows that the eggs are first

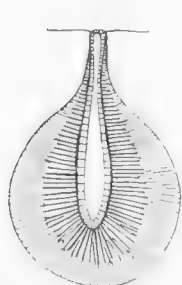


Fig. 16.

Fig. 16. *Phialidium hemisphæricum* (Gronovius). Transversal section through radial canal with mature male gonads.

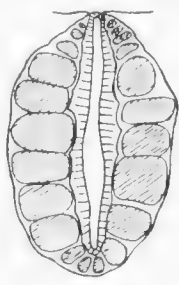


Fig. 17.

Fig. 17. *Phialidium hemisphæricum* (Gronovius). Transversal section through radial canal with female gonads.

developed in the middle part on both sides, whereas small, immature eggs are still present in the dorsal and ventral parts.

From the Faeroe Islands we possess a number of young specimens. In the smallest specimens (diameter 1–5 mm) the gonads are spherical and placed near the middle of the radial canals; in a specimen 7 mm wide the gonads (female) are oval, about 1¼ mm long; in the largest specimen (diam. 10 mm) they are elongate, 2 mm long.

In all specimens from Iceland the gonads are linear. Their length in relation to the length of the radial canals varies from ⅓ to nearly ¾, but stands in correlation to the developmental stage of the individual, as will be seen from table XII. This table represents the correlation between the diameter of the individuals and the relative length of the gonads (i. e. the relation between the length of the gonads and that of the radial canals, expressed by means of the figure $\frac{g}{r}$). For each individual I have calculated $\frac{g}{r}$ with 2 decimals, and these figures have been used for the calculation of the average numbers presented in the table. In the specimens examined the figure $\frac{g}{r}$ varies from 0.33 to 0.73. It will be seen from the table that up to a size of 6–10 mm in diameter the gonads have nearly the same relative length in both sexes ($\frac{g}{r}$ = about 0.4), but during the

Table XII. Relative length of gonads in specimens of different sizes of *Phialidium hemisphæricum* from Iceland.

Diameter of individuals, mm	$\frac{g}{r}$ relation between length of gonads and length of radial canals						Total	Average
	0.3	0.4	0.5	0.6	0.7			
♂								
6-10	1	1	.	.	.	2	0.39	
11-15	.	1	3	1	.	5	0.50	
16-20	.	.	1	5	.	6	0.59	
21-25	.	.	.	2	2	4	0.67	
Total	1	2	4	8	2	17 specimens		
♀								
6-10	.	3	.	.	.	3	0.42	
11-15	.	1	1	.	.	2	0.45	
16-20	.	2	4	1	.	7	0.49	
21-25	.	.	1	2	.	3	0.53	
Total	.	6	6	3	.	15 specimens		

further development there is a well marked difference between the sexes, the gonads being distinctly longer in the males than in females of corresponding sizes. The difference is so obvious that it can hardly be due to casuality. We may state, in short, that in full-grown specimens the male gonads are about $\frac{2}{3}r$, the female gonads about $\frac{1}{2}r$. — In large specimens the gonads, particularly the male gonads, are more or less sinuous.

Occurrence: The medusa *Phialidium hemisphæricum* is very abundant round the British coasts, in the North Sea, and in the Danish waters to the western part of the Baltic. Within this region it is found throughout the year. Young specimens are found in the spring and summer; during the summer we also find half-grown specimens; during the autumn and far into the winter we find large, full-grown specimens. The medusa has also been found at the coast of Norway in the neighbourhood of Bergen. Among the material, here dealt with, there are a number of small specimens from the Faeroe Islands, found in August, and numerous large individuals from the south coast of Iceland from July and August. — If Mayer (1910) is right that the "*Clytia flavidula*" of Metschnikoff is identical with *Phialidium hemisphæricum*, we will have to add the Mediterranean to the known area of distribution of the species.

***Phialidium islandicum* nov. spec.**

Plate IV, figs. 11, 12, 13; Plate V, figs. 1 and 2

Diagnosis: *Phialidium* of large size, with elongated gonads, with numerous tentacles and an equal number of marginal vesicles.

Description: Umbrella is watchglass-shaped, about 35–40 mm in diameter, gelatinous substance comparatively thin, exumbrella evenly rounded from the apex towards the margin. The stomach is cross-shaped, very small, its perradial diameter being only about one-tenth the diameter of the bell. There is a short mouth-tube provided with four pointed, crenulated lips (Plate IV, fig. 12). Four radial canals, straight and narrow, and a narrow, simple circular vessel. The gonads are developed on the radial canals, completely encircling the canal from both sides of its line of attachment to the subumbrella without leaving a ventral line free of gonads. The gonads are very much elongated, linear, usually not sinuous (Plate IV, fig. 11), commencing about 2 mm from the base of the manubrium, terminating about 1 mm from the circular vessel. The number of tentacles amounts to about 200; their basal bulbs are swollen (Plate V, fig. 1), particularly owing to the ectoderm of the lateral sides being highly developed; there is a slight trace of an abaxial process at the base of the tentacles. There are no cirri. Small, closed marginal vesicles (Plate IV, fig. 13) are present in the same number as the tentacles. Velum is fairly broad but thin and weak. — Hydroid generation unknown.

The number of species of *Phialidium* hitherto described is very large, and several of the species are very much like each other. It might be considered as rather a risky undertaking, therefore, to add a new species to the number already described, but as far as I am aware, there has never been found a *Phialidium* of such considerable size and with a similarly great number of tentacles as that found in the present species. It was pointed out in the preceding pages that *Phialidium hemisphæricum* may attain a larger size and a larger number of tentacles in the waters near Iceland than in the more

southerly parts of its area of distribution. It is possible, accordingly, that the species just described will prove in time to be only a northern giant variety of a species already known to science; but as long as it cannot be referred with certainty to any known species, I prefer to describe it as an independent species, for which I propose the name of *Phialidium islandicum*, because all the specimens in hand have been found in the neighbourhood of Iceland.

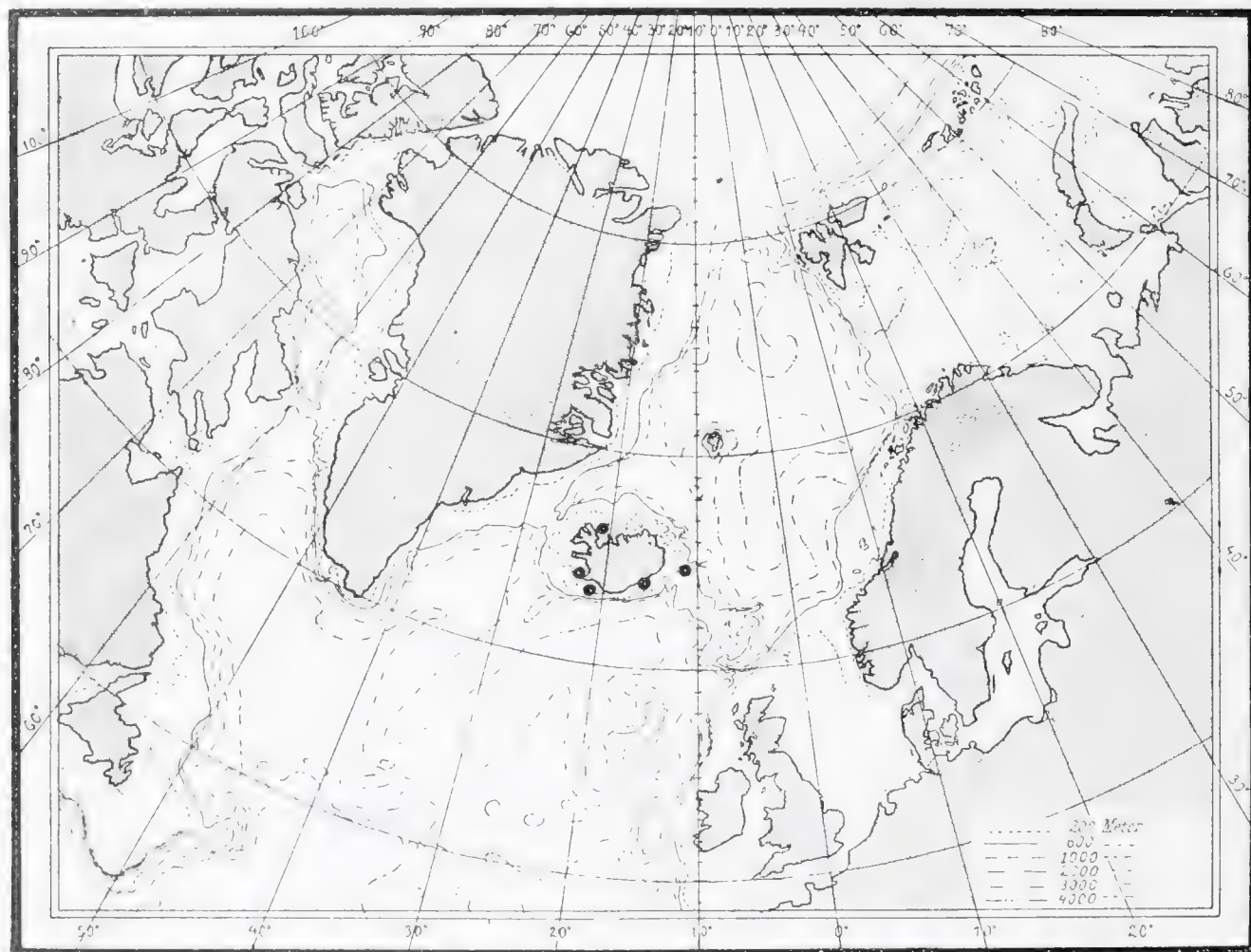


Chart XII. Finds of *Phialidium islandicum* nov. sp.

The species is quite distinct from *Phialidium hemisphericum*, not only by its size and the large number of tentacles, but also by the number of marginal vesicles never exceeding the number of tentacles. Furthermore the mouth-lips are larger and more crenulated than in the case of *Phialidium hemisphericum*, and the gonads are longer. The sagittal sections through the tentacular bulbs show (Plate V, figs. 2 and 3) that the ectoderm on the adaxial side of the bulb is more highly developed in *Phialidium hemisphericum* than in *Ph. islandicum*. The trace of an abaxial process on the base of the tentacular bulbs in *Phialidium islandicum* is not always distinct; in *Ph. hemisphericum* it is entirely lacking. The shape of the marginal vesicles (see the sections, Plate IV, figs. 13 and 14) presents no

particular difference; unfortunately the state of preservation does not allow a determination of the number of concretions in the marginal vesicles.

Material (see Chart XII):

1) — Myri Bugt, south coast of Iceland. July 27th 1904. "Beskytteren", Gemzoe. -- 2 specimens, 37—38 mm wide.

2) — Lat. $63^{\circ}18' N.$, Long. $21^{\circ}30' W.$, South-Iceland. July 8th 1904. Depth 178 m. "Thor" stat 176 (04). — 3 specimens, 22—28—35 mm wide.

3) — Lat. $64^{\circ}06' N.$, Long. $23^{\circ}14' W.$, Faxebugt. July 2nd 1908. Depth 98 m. Young-fish trawl, 65 m wire. "Thor" stat. 45 (08). — 1 specimen, 21 mm wide.

4) — Lat. $66^{\circ}23' N.$, Long. $21^{\circ}21' W.$, North-Iceland. August 24th 1904. Depth 108 m. Young-fish trawl, 70 m wire. "Thor" stat. 266 (04). — 1 specimen, 32 mm wide.

5) — Lat. $64^{\circ}35' N.$, Long. $11^{\circ}45' W.$, east of Iceland. August 8th 1904. Depth 348 m. "Thor" stat. 241 (04). — 2 large specimens, about 40 mm wide.

Table XIII. Diameter, number of tentacles, and length of gonads in
Phialidium islandicum from Iceland.

Number of locality	Diameter of individuals mm	Number of tentacles	Length of gonads mm	Sex
3	21	152		•
2	28	abt. 175	10	♀
4	32	abt. 200	11	•
2	35	abt. 185	11—12	♀
1	37	abt. 200	15	♂
1	38	200	15	♀

The specimens from loc. No. 5 are very large, about 40 mm wide; both specimens have lost the gastro-genital organs, but these are regenerating; in one specimen three new stomachs are developing; a nematode is enclosed in the gelatinous substance near the three stomachs.

As will appear from the above list of the material, this species has been found both south, west, north, and east of Iceland; it is probable, therefore, that it is derived from a hydroid widely distributed at the coasts of Iceland (possibly *Campanularia rotubilis?*). The specimens have all been found in July or August.

Genus *Euceilota* Mc Crady.

Euceilota maculata Hartlaub.

Mayer 1910, Medusæ of the World, p. 285.

Bell somewhat flatter than a hemisphere, about 13 mm wide. Gelatinous substance thick above, but thin at the sides of the bell. Stomach short, with 4 well-developed lips. 4 linear gonads along the outer two-thirds of the 4 radial canals, not touching the circular vessel. 16—30 long tentacles with well-developed, tapering basal bulbs, flanked by cirri. Cirri also arise from the bell-margin between the tentacles. Marginal vesicles, each containing 5—10 concretions, alternating with the tentacles. Gonads and tentacular bulbs light reddish-brown; on each interradiial wall of the stomach there is a large black spot.

The species occurs in the North-Sea, whence it is occasionally carried into the Kattegat.

Genus *Eutonina* Hartlaub.

Eutonina indicans Hartlaub.

- Tiarops indicans* Romanes 1876 b. New Species, Varieties, and Monstrous Forms of Medusæ. — Journ. Linn. Soc. London. Zool. Vol. XII. — p. 525.
- Tiaropsis* — Romanes 1877, *ibid.* — Plate XV, fig. 1.
- Thaumantias* sp. McIntosh 1888. Seventh Annual Report of the Fishery Board of Scotland. — p. 282, Pl. 5, figs. 6–9.
- - McIntosh 1890. Ann. Mag. Nat. Hist., Ser. 6. Vol. V. — p. 300.
- Eutimalphes indicans* Haeckel 1879. System der Medusen. — p. 195.
- — Hartlaub 1894. Die Coelenteraten Helgolands. — Wissensch. Meeresuntersuch. N. F., Bd. I. — p. 194.
- Eutonina* — Hartlaub 1897. Die Hydromedusen Helgolands. — *ibid.* Bd. II. — p. 507.
- *socialis* Hartlaub. *Ibid.* — p. 506. Taf. XXII, Fig. 1, 3, 4, 6, 7; Taf. XX, Fig. 19, 20.
- Eutimium* — Mayer 1910. Medusæ of the World. — p. 306.
- Eutonina indicans* Bigelow 1913. Medusæ and Siphonophoræ collected by the "Albatross" in the north-western Pacific 1906. — Proceed. U. S. Nat. Mus. Vol. 44. — p. 34.

Umbrella somewhat flatter than a hemisphere, 25–30 mm wide; gelatinous substance rather thick. Stomach small, cross-shaped, mounted upon a spindle-shaped peduncle reaching to the level of the bell opening; there are four crenulated lips. 4 radial canals. Gonads linear, wavy, developed upon the lateral sides of the radial canals, leaving a narrow median line on the ventral side free of gonads; the gonads commence at a short distance from the base of the stomachal peduncle and do not quite reach the circular vessel. There are about 200 short tentacles with conical basal bulbs; no cirri; 8 ad-radial marginal vesicles, each containing about 12 concretions. The velum is narrow.

Like Bigelow (1913) I prefer the generic name *Eutonina* Hartlaub for this medusa. Bigelow writes as follows: "Mayer uses the name *Eutimium* Haeckel for this group (he, however, does not include the number of tentacles as a generic character), but the type species of that genus, *E. elephas* Haeckel, was beyond question a *Eutima*. I formerly used the name *Eutimalphes*; but *Eutonina* seems to have the better claim, because its type species is well known, while that of *Eutimalphes*, *E. pretiosa* Haeckel, was founded for a fragmentary specimen which may have been a *Tima*. It has never been seen since first recorded".

With regard to the question of the specific name, it seems to me that Romanes' description of "*Tiarops indicans*" agrees so well with Hartlaub's description of "*Eutonina socialis*", that there is every probability that they are identical. The high shape of the bell in Romanes' medusa really presents the only noticeable difference and may, as is rightly remarked by Bigelow, very likely be due to contraction. Haeckel's characterisation of "*Eutimalphes indicans*" is a quotation of Romanes. The figure of "*Thaumantias* sp." given by McIntosh is not to be mistaken.

L. P. van Beneden (1867, p. 87, Pl. III, figs. 1–6) describes and figures a medusa, "*Geryonopsis Forbesii*", which is probably identical with *Eutonina indicans*; true, the gonads are most like those of

a *Tima*, but there are too many tentacles for a *Tima*, and the size and shape remind one very much of *Eutonina*. Bedot in his *Histoire des Hydroïdes* includes "*Geryonopsis Forbesii*" among the synonyms of *Irene viridula* Pér. & Les. Peach (1868, p. 97) mentions a medusa, "*Tima Forbesii*", which is said to be distinguished from *Tima bairdii* by the possession of numerous tentacles; probably also this medusa belongs to *Eutonina indicans*. The same may be the case with a medusa mentioned by Crawford (1891, p. 296): "A form evidently allied to *Tima*, but with shorter peduncle, with more numerous tentacles, and with the reproductive organs only on a portion of the canals".

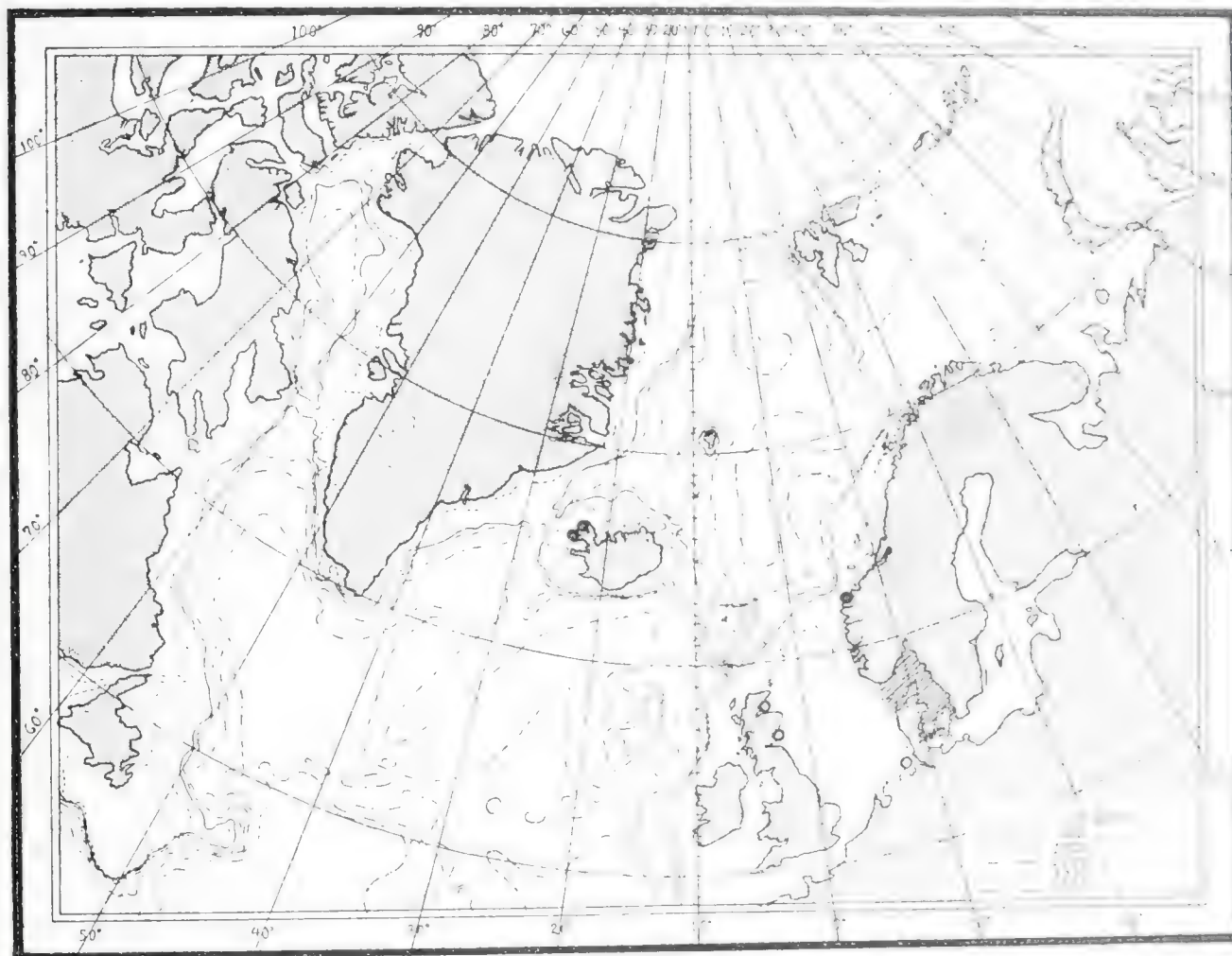


Chart XIII. Occurrence of *Eutonina indicans* in the Atlantic. O Occurrence according to the literature
In the hatched region the species has a common occurrence.

Material (see Chart XIII):

- 1) — Isafjord, north-western part of Iceland. Mariboe 1865. — 1 specimen, 22 mm wide. Identified by Haeckel as "*Eirene (viridula) Esch.?*".
- 2) — Patreksfjord, north-western part of Iceland. June 22nd—23rd 1904. Fished from the ship "Thor" stat. 159 (04). — 2 specimens, 12, 14, and 17 mm wide.
- 3) — Borgundfjord, near Aalesund, Norway. June 25th 1902. "Michael Sars", Ad. S. Jensen. 19 specimens, about 16—27 mm wide.

Moreover the Zoological Museum of Copenhagen possesses a large number of specimens from Danish waters, where this species is exceedingly abundant right into the Belt-Sea.

It is very interesting that Bigelow has found this North-European species in the northern Pacific. Bigelow states that "the only noticeable separation between examples from the two localities is that in those from the Bering Sea the gonads begin close to the base of the peduncle, instead of at a slight distance from it, as in the Helgoland specimens, but the difference is so slight that it is probably a developmental feature". I have paid attention to this statement, and I have found that the authors last-mentioned supposition does not hold good; as a matter of fact, in young as well as full-grown individuals there is always some distance from the stomachal peduncle to the proximal end of the gonads (see Table XIV).

Table XIV. Dimensions of specimens of *Eutonia indicans* from the above-mentioned localities.

Number of locality	Diameter of individuals mm	Number of tentacles	Length of gonads mm	Distance from		Sex	Remarks
				gonads to stomachal peduncle mm	gonads to circular vessel mm		
2	12	171	4 $\frac{1}{2}$	1 $\frac{1}{4}$	1	♂	somewhat contracted
—	14	abt. 185	...	1 $\frac{1}{4}$	1	♀	
—	17	169	...	1 $\frac{1}{2}$	1	♀	
1	19	175	4	2 $\frac{1}{4}$	1 $\frac{1}{4}$	♀	immature
3	22	...	7—8	1 $\frac{1}{2}$	1	♀	somewhat contracted
1	25	206	6 $\frac{1}{2}$	2 $\frac{1}{4}$	1 $\frac{1}{4}$	♀	mature
—	26	abt. 196	7	3 $\frac{1}{4}$ —3 $\frac{1}{2}$	1	♂	—
—	26	188	6	3	1 $\frac{1}{2}$	♀	hardly mature
—	27	204	8	2 $\frac{3}{4}$	1	♂	mature
—	27	213	6 $\frac{1}{2}$	3	1	♂	—

Measurements on Danish specimens have given corresponding results with regard to the distance from the base of the stomachal peduncle to the proximal end of the gonads; thus there actually seems to exist a characteristic difference in this respect between the specimens from Europe and those from the Bering Sea; but as they agree exactly in all other respects, this slight difference hardly justifies a separation of the two forms as distinct species, unless the corresponding hydroids should prove to be specifically different.

Hartlaub gives the number of tentacles as about 150, but, as will appear from the figures in table XIV, the number may amount to about 200.

Eutonia indicans has up to now been found on the following localities in the Atlantic area: east coast of Scotland: Cromarty Firth (Romanes) and St. Andrews Bay (McIntosh); Heligoland (Hartlaub); and, if "*Geryonopsis Forbesii*" van. Beneden is identical with the present species, also off the coast of Belgium. It is mentioned in the International Plankton-lists as occurring in the Skagerrak. In Johansen and Levinsen: De danske Farvandes Plankton (1903), it has been confounded with *Tiaropsis multicirrata*.

The present material augments the known area of distribution to comprise the west coast of Norway at Aalesund and the fjords on the north-western part of Iceland.

The Norwegian specimens as well as those from Patreksfjord in Iceland are found in the later half-part of June. The species is said to occur off the east coast of Scotland from May to August. It occurs at Heligoland from the end of March to the beginning of July and may be carried into the beach in enormous quantities. It is found in the Danish waters from the beginning of April to the end of June. In May 1916 I saw enormous quantities at the surface of the water in Lillebelt.

Genus *Saphenia* Eschscholtz.

Saphenia gracilis (Forbes and Goodsir).

Mayer 1910, *Medusæ of the World*, p. 294.

Syn. *Saphenia mirabilis* (Wright) Haeckel.

Bell hemispherical, about 15–20 mm wide. There is a long and thin, cylindrical gelatinous peduncle which may be extended to a length of 5–10 times the diameter of the bell. The peduncle is entirely surrounded by the four linear gonads, which extends from the base of the peduncle to the stomach; the latter is small, flask-shaped, with 4 small, recurved lips. Two long, opposite tentacles and a large number of marginal warts and cirri. 8 adradial marginal vesicles, each containing about 3 concretions. Stomach and gonads delicately pink.

British coasts and North Sea.

Genus *Eutima* McCrady.

Eutima insignis (Kieferstein).

Mayer 1910, *Medusæ of the World*, p. 299.

Umbrella hemispherical, about 8 mm wide. The stomachal peduncle is once or twice as long as the diameter of the bell, narrow, of equal width. Stomach about half as long as the bell-radius, flask-shaped, with 4 large lips. The gonads extend from near the stomach upwards along the 4 radial canals on the peduncle; there are no gonads on the subumbrella. There are 4 long perradial tentacles, each flanked by a pair of cirri; moreover there are about 30 rudimentary bulbs, likewise flanked by cirri. 8 adradial marginal vesicles, each containing 2–5 concretions. The animal is colourless.

British coasts and north-west coast of France.

Eutima elephas (Haeckel).

Mayer 1910, *Medusæ of the World*, p. 300.

Umbrella about 16–20 mm wide; gelatinous substance thick. The upper part of the stomachal peduncle is broadly conical; the entire length of the peduncle is about 3 to 4 times the diameter of the bell. Stomach short, urn-shaped, with 4 recurved, slightly folded lips. 4 radial canals; the gonads are developed along the radial canals on the narrow part of the peduncle. There are 4 long perradial tentacles and numerous minute warts on the bell-margin; no cirri; 8 adradial marginal vesicles, each containing about 8–10 concretions. Stomach, canal system, and tentacles green.

North Sea.

Genus *Octorchis* Haeckel.

Octorchis gegenbauri (Haeckel).

Syn. *Eutima campanulata* (Claus). Mayer 1910, *Medusæ of the World*, p. 302.

Umbrella hemispherical, about 25–30 mm wide. Stomachal peduncle about as long as the bell-diameter, the upper part broadly conical. Stomach small, urn-shaped, with 4 folded lips. 4 radial canals; the gonads are developed partly along the subumbrella part of the radial canals, partly on the peduncle about half-way between the base of the peduncle and the stomach. There are 16–32 long tentacles and about 120–150 tubercles, flanked by cirri. 8 adradial marginal vesicles, each containing 16–20 concretions. Stomach, canal-system, gonads, and tentacles greenish.

North Sea, Atlantic coasts of Great Britain and France, Mediterranean, Canary Islands.

Genus *Eirene* Eschscholtz.

Eirene viridula (Péron et Lesueur).

Mayer 1910, *Medusæ of the World*, p. 311.

Umbrella very flat, about 6–15 mm wide; gelatinous substance thin. Stomachal peduncle half as long as bell-radius, pyramidal, slender. Stomach small, with 4 long, crenulated lips. 4 radial canals, very narrow. Gonads linear, somewhat sinuous, developed along the subumbrella parts of the radial canals. 50–60 short tentacles and about 100 even smaller tentacles; each of the latter is flanked by a pair of cirri; each of the tentacular bulbs bears an abaxial excretion papilla. There are about 100 small marginal vesicles, each containing 2–4 concretions. Velum very narrow. Stomach, gonads, and tentacles milky-white, green or reddish.

Atlantic coasts of Europe, Mediterranean.

Genus *Tima* Eschscholz.

Tima bairdii (Johnston) Forbes.

Plate V, figs. 4, 5, 6, 7, 8, 9, 10.

Dianœa Bairdii Johnston 1833. *Illustrations in British Zoology*. Art. IV. — *Mag. Nat. Hist.* Vol. 6. — p. 320, fig. 41.

— — Thompson 1844. *Report on the Fauna of Ireland, Invertebrata*. — Rep. 13th Meeting, Brit. Assoc. — p. 282.

Tima? — Forbes 1846. *On the Pulmograde Medusæ of the British Seas*. — *Ann. Mag. Nat. Hist.* Vol. 18. — p. 286.

Medusa (Tima) Eschsch. Dalyell 1847–48. *Rare and remarkable Animals of Scotland*. Vol. 2. — p. 250; Pl. 52, fig. 5.

Tima Bairdii Forbes 1848. *British Naked-eyed Medusæ*. — p. 37; Pl. 5, fig. 1.

— — Allman 1871. *Monograph of the Gymnoblasic or Tubularian Hydroids*. — pp. 36, 140, figs. 11, 12.

Böhm 1878. *Helgolander Leptomedusen*. — *Jenaische Zeitschr.* Bd. XII (N. F. Vol. I). — pp. 143, 145.

— — Haeckel 1879. *System der Medusen*. — p. 205.

Description:

Umbrella hemispherical or somewhat higher than a hemisphere, about 60 mm wide when fully developed. Gelatinous substance very thick. The stomachal peduncle is nearly conical; it is highly contractile; its length as well as the width of its base are, accordingly, very much variable, and measurements of preserved material are, therefore, of no great value; but the approximate dimensions may be stated as follows: The diameter of the base of the peduncle varies between about $\frac{1}{2}$ and $\frac{2}{5}$ of the diameter of the bell; the length is, when expanded, about equal to the bell-diameter, the peduncle extending more or less beyond the level of the bell-margin.

The stomach (Plate V, fig. 5) is small, square, fixed to the flattened terminal end of the peduncle by a cross-shaped figure; thus there are four flat, triangular pouches between the dorsal wall of the stomach and the terminal end of the peduncle. In some cases, i. e. in certain conditions of contraction, the entire stomach is cross-shaped in transverse section. The four perradial lines of attachment

(the cross-arms) are seen, from the stomachal cavity, as deep, narrow grooves (Plate V, fig. 4). From the distal ends of these four grooves issue the four radial canals which, from these points, run upwards along the peduncle (Plate V, fig. 5). The openings of the radial canals may be completely closed by contraction of the borders of the grooves, thus the lumen of the canals being separated from the cavity of the stomach; in the stomach figured in Plate V, fig. 4, the openings on the left side have been closed in that manner.

The basal part of each radial canal is a little widened and has a number of fine, transverse folds.

The mouth-opening is wide and is provided with four large, pointed lips, complexly folded and with a crenulated margin (Plate V, fig. 5).

There are four straight radial canals and a very narrow circular vessel. The mode of attachment of the radial canals to the subumbrella (and the stomachal peduncle) is remarkable (see Plate V, fig. 10). The usual median streak of high entodermal cells is very narrow, but the uppermost parts of the lateral entodermal layer of the canal on both sides are attached to the subumbrella, the ectoderm and the mesosarc leaving the subumbrella at some distance from the median streak; thus the line of attachment has secondarily become rather broad.

The gonads are developed upon both sides of the radial canals from the attachment to the subumbrella, leaving a narrow median line free on the ventral edge. Though the line of attachment to the subumbrella is straight, the lateral walls of the canals are, in the parts carrying the gonads, very much folded in a fairly regular, wavy manner. The gonads extend partly over the subumbrella from the base of the peduncle towards the bell-margin, reaching nearly to the circular vessel, partly downwards along the peduncle, ceasing at a distance of some few millimeters above the stomach. The gonads attain their highest development and are most highly folded upon the subumbrella, gradually tapering during their course downwards upon the peduncle. Sections laid through different parts of the gonads of one and the same specimen show, however, that the sexual products are in the same state of maturity in every part. In the highly folded parts the ventral median line, free of gonads, is sometimes fairly broad, sometimes very narrow, shaped like a deep furrow, and is, in such cases, hardly visible, except in sections.

The usual number of tentacles is 16. When fully expanded, the length of the tentacles is about 3 times the diameter of the bell. The tentacular bulbs (Plate V, figs. 6, 7, 8) are oblong, pear-shaped, gradually passing into the thread-like part of the tentacles. The ectoderm of the bulb is somewhat thickened, equally developed all round the bulb (Plate V, fig. 8). Proximally the abaxial side of the bulb is sharply set off from the exumbrella. There is a well-developed, hollow, entodermal basal spur projecting into the gelatinous substance of the exumbrella, curving outwards and upwards, its abaxial side resting close to the exumbrellular epithelium, which is slightly thickened in this part (Plate V, fig. 8). Above each of the tentacles there is a slight, rounded prominence of the exumbrella (Plate V, figs. 6 and 7); this may be due to contraction owing to the preservation. The points of insertion of the tentacles are usually not quite equidistant.

Between the tentacles there is a large number of marginal warts (see Plate V, fig. 6). The base of the warts is rectangular, the warts being placed closely together. In some cases they are separated from each other by a sharp furrow, but sometimes they pass gradually into one another; it is difficult,

therefore, to state their exact number; in well-grown specimens there may be about 200–250 warts. The ectoderm of the warts is somewhat thickened (Plate V, fig. 9). On the abaxial side of some of the warts may be found a small tenon, a rudimentary tentacle.

The marginal vesicles are very numerous, about half as numerous as the warts; they are situated, with a broad base, in the middle of the adaxial side of the warts, close to the velum (Plate V, fig. 9).¹⁾ Marginal vesicles are never found on warts provided with tentacular rudiment. As all of the material at my disposal has been preserved in formalin and left there for several years, the concretions of the marginal vesicles have been dissolved; according to Allman (1871) the number of concretions in each marginal vesicle varies from 4 to 20 in one and the same specimen.

The velum is well-developed and as broad as the length of the tentacular bulbs.

In living specimens the tentacles are said to be light pink.

Though this medusa is very common in the North Sea and adjacent waters, no description has been given since 1848 (Forbes). It was first discovered by G. Johnston (1833) who made a short description and a somewhat rough figure of the species. A very fine drawing was given by Dalyell (1847–48). The description delivered by Forbes (1848) was rather incomplete. A few morphological remarks are found in the works of Allman (1871) and Böhm (1878). The description in Haeckel's monograph (1879) is based on the descriptions and drawings of Dalyell and Forbes. — The records on the occurrence of the species are likewise rather few. It is no wonder, therefore, that Mayer (1910, p. 319) has an entirely incorrect interpretation of the relationship and distribution of the species. Mayer suggests that *Tima bairdii* may prove to be the young of *Tima formosa* which is found off the Atlantic coasts of New England, and that it is an arctic form occasionally appearing at the coasts of Scotland.

Tima formosa L. Agassiz reaches twice the size of *Tima bairdii* and has about 32 tentacles of three different sizes; according to Bigelow (1913, p. 36) the number of tentacles may amount to 39; it has about 100 marginal warts, whereas *Tima bairdii*, though it is a smaller species, may have more than 200. Mayer (1910, p. 317) and Bigelow (1913, p. 36) confirm the statement of A. Agassiz, that the marginal vesicles in *Tima formosa* alternate with the warts, being placed in the spaces between the latter; in *Tima bairdii* they are placed on the warts themselves (see above). The two species may be nearly related to one another, but they are clearly distinct species.

More peculiar is the suggestion of Mayer (1910, p. 319), that *Tima flavilabris* Eschscholtz might be the young of *Tima formosa*. It is not very likely that a large species with about 80 short tentacles might be a young stage of a smaller medusa with only 32 tentacles. *Tima flavilabris* Eschscholtz from the Azores is, without any doubt, identical with *Tima lucullana* Delle Chiaje from the Mediterranean, *flavilabris* being the correct name of the species².

Besides the species already mentioned, we know another Atlantic species of *Tima*, viz. *Tima teuscheri* Haeckel from the coast of Brazil, possessing 8 long and 40 short tentacles.

¹⁾ A. Agassiz in his description of *Tima formosa* states that the marginal vesicles are situated in the spaces between the warts

²⁾ The question of the correct name of this species will be discussed in a later work.

In the Pacific the genus is represented by *Tima saghalinensis* Bigelow (1913, p. 35), a large species, distinguished by its very short peduncle and by the lips being extraordinarily complexly folded.

Material:

I have had at my disposal for investigation numerous specimens from Danish waters, but only 4 specimens from one locality outside the Danish area:

Lat. 55°10' N., Long. 1°55' E. May 3rd 1905. Depth 33 m. Young-fish trawl. "Thor" stat. 1405 — 4 specimens, diameter: 35, 42, 43, and 58 mm.

The Danish specimens have been found at 23 different localities in the North Sea, the Skagerrak, the Kattegat, and the northern part of the Sound. The species has also been found in the northern part of the Lillebelt.

I am not going to give a thorough account of the Danish finds in this place, but shall restrict myself to make some few remarks on the appearance of a number of young specimens.

Most of the specimens, examined by me, are large and medium-sized, the largest being 58 mm in diameter. But there are also some young specimens, the smallest being 6 mm. The height of a specimen, 6 mm wide, is 4 mm, the gelatinous substance being 2 mm thick apically, and the depth of the bell-cavity being likewise 2 mm. — The peduncle is short in these small specimens. In a specimen, 13 mm wide, the peduncle is 4 mm long, 3 mm wide at the base.

When the diameter is below 13 mm only slight traces of gonads are present, and they are confined to the subumbrella part of the radial canals, ranging from the base of the peduncle very nearly to the circular vessel.

Three of the specimens, which are 6, 7, and 10 mm wide, have 8 tentacles, all alike; 8 adradial swellings just visible indicate the places of the remaining tentacles. In two specimens, 11 and 13 mm wide, one of the adradial tentacles has developed, but is much smaller than the 8 perradial and interradial ones. One specimen, 13 mm wide, possesses 16 tentacles, the perradial and interradial all alike, while the others are much smaller and in different stages of development. I have not seen specimens with less than 8 tentacles, and these have always been of equal size in the same individual. The number of marginal vesicles in these small specimens (6—13 mm) is 29—34. A specimen, 23 mm wide, has about 84 marginal vesicles.

One of the specimens from the above-mentioned locality in the western part of the North Sea is abnormal, in so far as one of the four quadrants is narrower than the others, and there are no tentacles between the two adjacent radial canals. I have observed the same abnormality in no less than 3 of the Danish specimens.

Distribution (see Chart XIV):

This large medusa seems to be strictly confined to the North Sea, the Skagerrak, and the Kattegat. It has been recorded from Berwick Bay (Johnston 1833), May Island (Dalyell 1847—48), Burtisland (Forbes 1848), and St. Andrews Bay (Forbes 1848, McIntosh 1890, Crawford 1891); all these localities are at the southern part of the east coast of Scotland. According to McIntosh the species abounds all along the eastern shores of Great Britain to the estuary of the Thames (Mc

Intosh 1890, p. 304), but no precise records are given. Hartlaub (1894, p. 196) has found it at Heligoland. Broch (1905, p. 7) records it from the Sondeledfjord on the Norwegian coast of the Skagerrak. In the International Plankton Catalogues (1906 and 1908) it is recorded from various localities in the eastern part of the Skagerrak. Also Aurivillius (1897—98) records it from the Skagerrak. A. C. Johansen and Chr. Levinsen (1903) have mentioned it from the Kattegat. No other records as to the

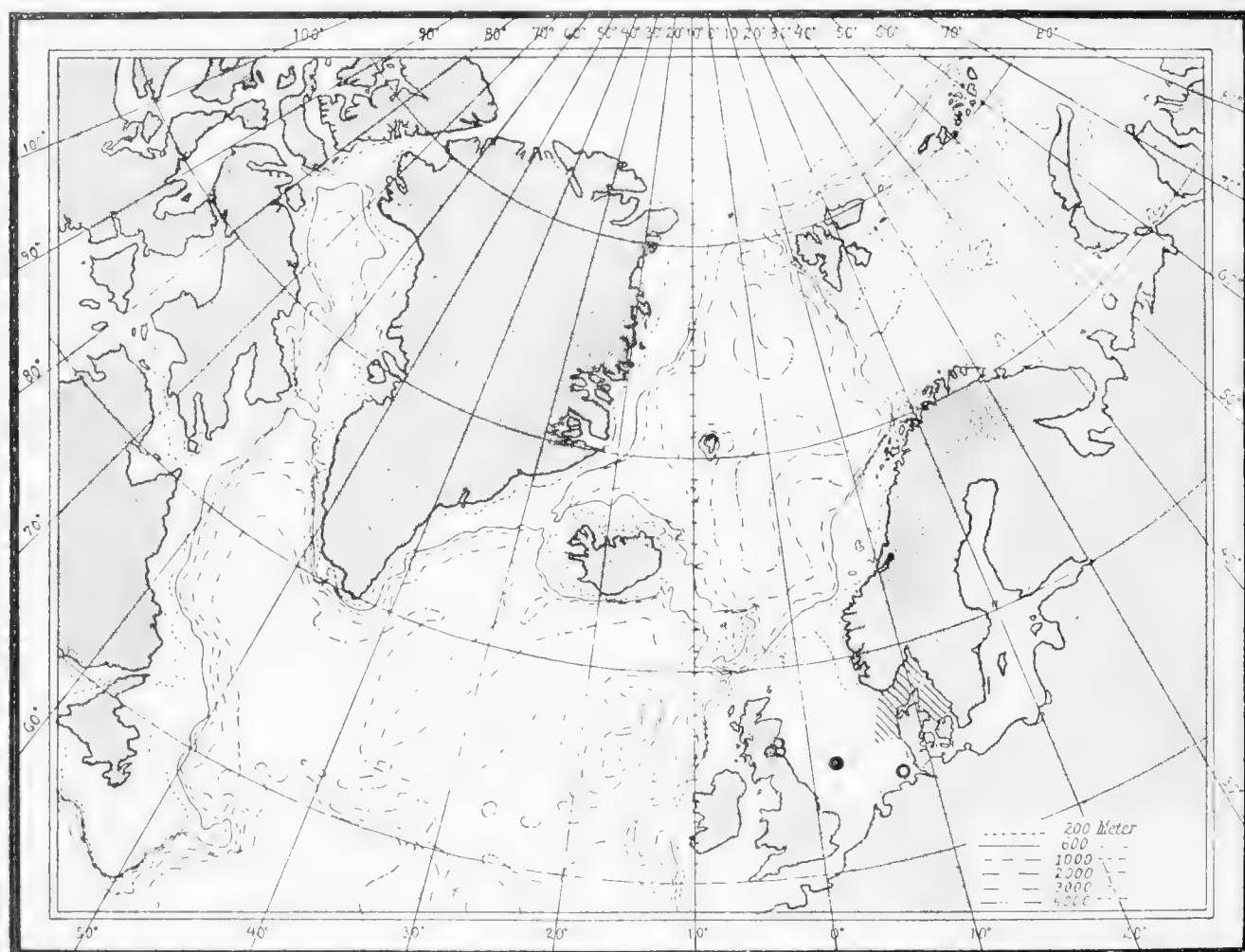


Chart XIV. Occurrence of *Tima bairdii* Fewkes. O Occurrence according to the literature.
Within the hatched region the species has a common occurrence.

occurrence of *Tima bairdii* are found in the literature. Thus it seems certain that it does not occur north and west of the North Sea. It is very remarkable and interesting that the distribution of one of the largest species among the Leptomedusæ of the North-European waters is entirely restricted to a comparatively small area.

Tima bairdii may be found at different depths. Most frequently it has been found in the upper water layers, but in the Skagerrak it has been found near the bottom at considerable depths, viz. 105, 140, 254, and 547 m.

Seasonal occurrence: Off the British coasts large specimens are found during the autumn and winter, apparently not later than the end of January; according to McIntosh young specimens have been found in February, May, and August. — In the Danish waters quite young specimens have been found in June and July; large specimens occur during the winter and early spring from November to April, rarely in May.

Family *Æquoridæ*.

Genus *Æquorea* Péron et Lesueur.

Æquorea forskålea Péron et Lesueur.

Mayer 1910, *Medusæ of the World*, p. 325.

Umbrella usually flatter than a hemisphere, up to about 400 mm wide; gelatinous substance thick in the middle part, thin at the margin. Stomach wide, mouth usually widely gaping, with several pointed lips. Numerous simple radial canals (up to about 200), carrying the gonads. Numerous tentacles of varying length. No cirri. Marginal vesicles even more numerous than the tentacles, each containing 2–4 concretions. Colour highly variable.

The species is widely distributed, but the distribution cannot be stated exactly, because we are not yet able to establish the limitations between the different species or varieties of *Æquorea* described. It has been found off the Atlantic coasts of Great Britain and the northern part of Norway.

Genus *Zygodactyla* Brandt.

Zygodactyla groenlandica (Péron et Lesueur).

Mayer 1910, *Medusæ of the World*, p. 335.

Umbrella usually flatter than a hemisphere, large; gelatinous substance very thick in the middle part, thin at the margin. Stomach broad, flattened, with a prolonged, cylindrical mouth-tube; the mouth is provided with long, pointed lips, equal in number to the radial canals. About 100 simple radial canals, carrying the gonads; between each successive pair of radial canals the subumbrella carries a row of gelatinous, wart-like protuberances. Tentacles slightly more numerous than the radial canals, long, with tapering bulbs. Between each successive pair of tentacles there are about 8–12 marginal vesicles, each containing 2 concretions. There are no cirri. Velum rudimentary. Colour of gastro-genital system and tentacles very delicately pink.

East coast of North America and west coast of Greenland.

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Errata.

- Page 19, line 29 stands: stat. 241 (09), read: stat. 241 (04).
- 46, line 17 stands: sout, read: south.
- 59, text, line 3 stands: (1905), read: (1909).
- 85, text, line 4-5 stands: textfig. 14, read: textfig. 15.

Explanation of the Plates.

List of abbreviations.

- ap. j. apical jelly.
- c. cordylus.
- c. v. circular vessel.
- ex. exumbrella.
- g. gonads.
- m. e. mouth-edge.
- m. v. marginal vesicle.
- m. w. marginal wart.
- n. nematocysts.
- r. c. radial canal.
- r. s. line of connection between radial canal and subumbrella.
- sp. tentacular spur.
- st. d. dorsal wall of stomach.
- st. l. lateral wall of stomach.
- st. p. stomachal peduncle
- sub. subumbrella.
- t. tentacle.
- v. velum.

Plate I.

Plate I.

Figures 1—8 *Chromatonema rubrum* (Fewkes).

- Figure 1. A specimen from the Davis strait, "Tjalfe" stat. 336. Diameter 17 mm, height 14 mm. — $\times 5$.
- 2. Part of the bell-margin with two tentacles and three cordyli. — "Tjalfe" stat. 336. — $\times 20$.
- 3. Cordylus with nematocysts. — "Tjalfe" stat. 336. — $\times 65$.
4. Lateral view of a part of a radial canal with four female gonads. The gonads are faintly discerned through the lateral wall of the radial canal. The subumbrella has been lifted up in front in order to make it possible to peep into the pouches between the subumbrella and the dorsal wall of the radial canal. The eggs are visible, and the fissures leading to the inner, narrow lumen of the gonadial sacks are seen. — $\times 12$.
- 5. Horizontal longitudinal section through the lower part of the gonadial sacks. In most of the gonads the inner lumen with its ectodermal epithelium is seen. Two of the gonads on the left side have been hit so far below, that the lumen has not been touched by the section. — $\times 24$.
- 6. Horizontal longitudinal section through the same radial canal. This section has passed through the upper part of the gonadial sacks, showing the openings of the gonads into the bell cavity. — $\times 24$.
- 7. Transverse section of a radial canal with two female gonads. The gonad to the left has been hit nearly in the middle, exhibiting the entodermal (outer) epithelial cover of the sack, the eggs, and a small part of the ectodermal epithelium of the lumen. On the right side the section has just passed through the entodermal epithelium of the gonad. Above the left gonad is seen the pouch between the dorsal wall of the canal and the subumbrella. On the right side the section has passed through one of the branches of the line of attachment of the canal. — $\times 25$.
8. Transverse section through a radial canal with two male gonads. To the left the section has passed nearly through the middle of the gonad, showing the ectodermal lumen, the spermatocytareous and the spermatogonial parts of the testis, and the entodermal epithelium of the sack. On the right side the section has passed mainly through the spermatogonial part of the testis. The ventral part of the canal is wanting. — "Thor" stat. 93 (04). — $\times 25$.
- 9. *Staurophora mertensii* Brandt. — A part of the bell-margin of a specimen from Borgundfjord near Aalesund, Norway. Showing tentacles with entodermal spurs, cordyli, and centripetal furrows in the exumbrella. — $\times 30$.
10. *Melicerium octocostatum* (M. Sars). — Radial canal seen from the subumbrella side. A part of the lateral wall of the stomach is seen from the inner side, showing the vertical fissure connecting the radial canal with the stomach cavity. — "Thor" stat. 203 (04). — $\times 10$.

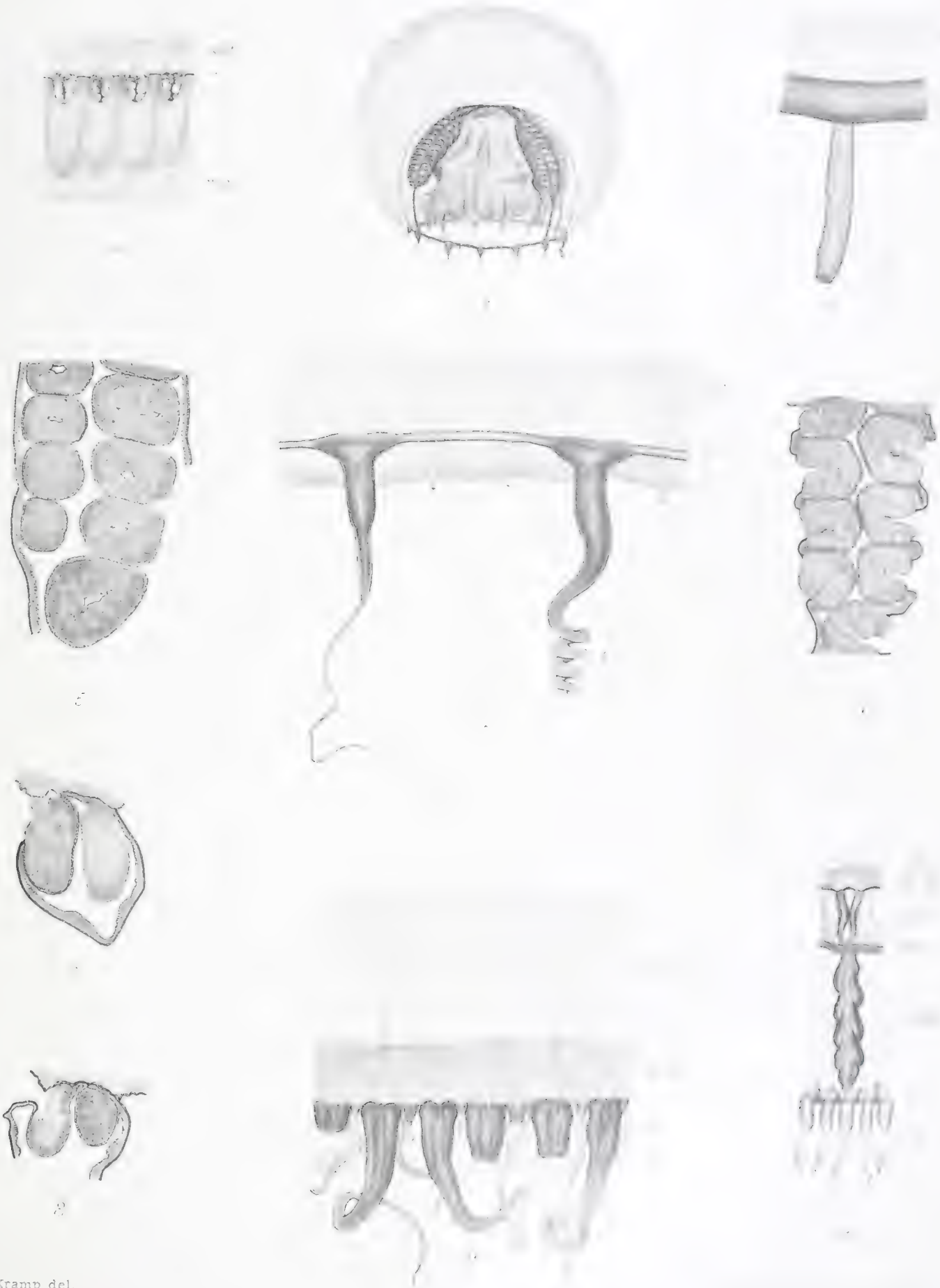


Plate II.

Plate II.

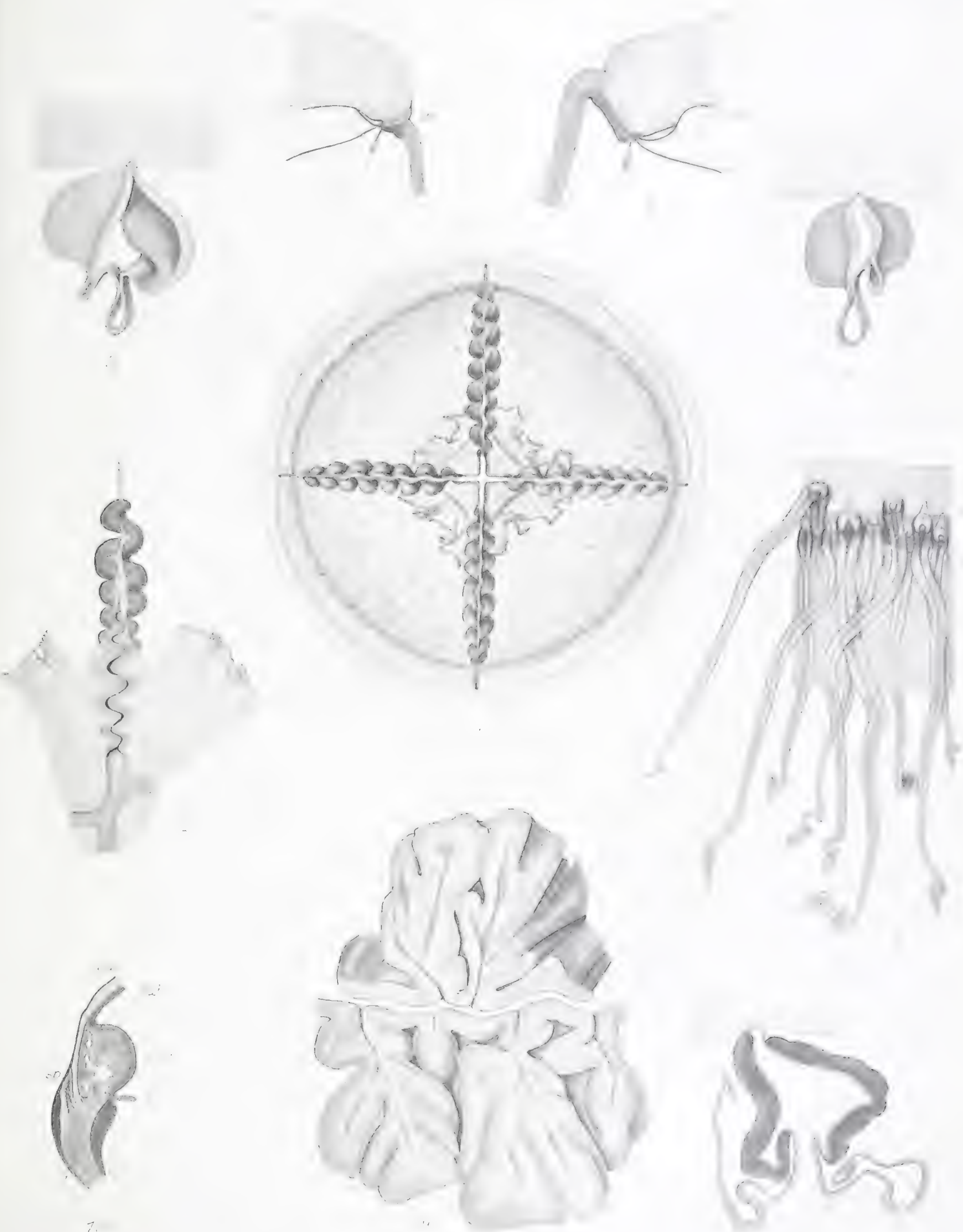
Figures 1—8 *Laodicea undulata* (Forbes and Goodsir).

Figure 1. A specimen seen from the top. — $\times 3$.

- 2. Radial canal with gonads and a part of the stomach; showing the grooves along which the dorsal wall of the stomach is attached to the subumbrella. The corner of the mouth and the ventral side of the funnel-shaped part of the radial canal have been cut open. The gonads commence at the point, where the open groove becomes closed by means of the two lateral folds, mentioned in the text (p. 17). The dark, wavy line is the narrow, nearly closed fissure between these folds, connecting the space between the gonads with the stomach and the funnel-shaped dilatation. The proximal parts of the gonads are faintly visible through the dorsal wall of the stomach. — From a specimen, about 25 mm in diameter, from Myri Bugt, Iceland, July 21st 1904. — $\times 6$.
- 3 and 4. Transverse sections (made by hand) through the radial canal of a male specimen from "Michael Sars" stat. 140, June 26th 1903. Showing the lateral folds of the walls of the canal containing the sexual products, and, below, the funnel-shaped part of the canal.
- 5 and 6. Radial sections (made by hand) through the bell-margin with tentacles in different stages of development. The tentacle represented in fig. 5 is comparatively young and has a well-developed basal spur. The tentacle in fig. 6 is fully developed the basal part of the abaxial side of the tentacle has grown upwards along the exumbrella and caused the spur to disappear. Observe the ectodermal thickening on the adaxial side, and the course of the central canal.
- 7. Transverse section (microtome-section) through the dorsal wall of the stomach near the corner of the latter, showing male gonads and the two lateral folds. Owing to the preparation these have separated a little from one another, thus not completely separating the space between the gonads from the stomachal cavity. — "Michael Sars" stat. 140 (03). — $\times 30$.
- 8. Part of the bell-margin seen from the abaxial side, with tentacles, cordyli, and a single cirrus (to the left). In two of the tentacles the spur has disappeared. — Myri Bugt, Iceland, July 24th 1904. — $\times 15$.

Figures 9—10 *Staurophora mertensii* Brandt.

- Figure 9. Complexly folded gonads seen from above. The gonads have been carefully detached from the subumbrella, showing the branched lines, by which they have been attached. — Myri Bugt, Iceland, August 9th 1904. — $\times 10$.
10. Longitudinal section through a tentacular bulb and the circular vessel. The gelatinous substance of the bell-margin is much shrivelled. — "Thor" stat. 45 (08). — $\times 50$.



7.

Plate III.

Plate III.

Figures 1—6 *Ptychogena lactea* A. Agassiz.

- Figure 1. Dorsal wall of the stomach seen from the inner side, showing the four grooves, which in this specimen do not meet exactly in the centre. The margins of the grooves are developed into lateral, longitudinal folds, which transform the grooves into closed canals, which open into the stomach near the centre; these openings are seen in the figure. — From a specimen, 90 mm wide, from "Tjalfe" stat. 125. — $\times 3$.
- 2. Transverse section of a radial canal with two lamellæ with their papillæ. The lower part of the figure represents the funnel-shaped, ventral part of the radial canal, separated from the narrow, dorsal part by the two longitudinal folds, which are clearly visible in the figure. — From the same specimen. — $\times 6$.
- 3. Part of the conical part of a radial canal. The ventral wall is partly cut away, so that the longitudinal folds, which separate this part from the narrow, dorsal part, are visible. — From the same specimen. — $\times 6$.
- 4. Longitudinal section through a part of a radial canal, showing the entrances to the lateral pouches, the longitudinal fold, and the lateral wall of the funnel-shaped part of the canal. — From the same specimen. — $\times 6$.
- 5. Transverse section through four of the lamellæ (parallel with the radial canal) with male gonads. In the second lamella from the right the section has passed through the middle of one of the papillæ, demonstrating that the lumen of the latter communicates with the lumen of the lamella. In the first lamella from the right the section has touched one of the papillæ. In the papillæ the entoderm consists of a single layer of cubical cells; in the lamellæ there are several layers of smaller entodermal cells. — Microtome-section. — From the same specimen. — $\times 20$.
- 6. Radial section through the bell-margin, showing a tentacle and a cordylus. On the abaxial side of the base of the tentacle is seen the short conical extension, the rudimentary spur. The cordylus is mounted upon a small tubercle. — From a specimen from Lat. $59^{\circ}07' N.$, Long. $13^{\circ}32' W.$ One of the type-specimens of *Ptychogena pinnulata* Haeckel. — $\times 17$.
- 7 a—f. *Staurophora mertensii* Brandt. — Examples of cordyli developing into tentacles (see p. 6 in the text). — From a specimen from Iceland, "Thor" stat. 208 (04). — $\times 20$.
- 8. *Melicerium octocostatum* (M. Sars). — Transverse section through a radial canal with female gonads. Showing the broad line of attachment to the subumbrella and the considerable distance from the subumbrella to the upper edge of the gonads. — From a specimen from Iceland, "Thor" stat. 258 (04). — $\times 50$.



Plate IV.

Plate IV.

Figures 1—5 *Halopsis ocellata* A. Agassiz.

- Figure 1. A male specimen, 35 mm wide, seen from the aboral side. — Iceland, "Thor" stat. 179(04). — $\times 2$.
- 2. Part of the bell-margin seen from the abaxial side; showing 5 tentacles, 4 cirri, 1 marginal vesicle, and the velum. — From a specimen, 35 mm wide, from the Vestman Islands. — $\times 28$.
- 3. Mature male gonad. — From the same specimen as fig. 1. — $\times 5$.
- 4. Mature female gonad. — From a specimen, 30 mm wide, from between Iceland and the Faeroe Islands. — $\times 5$.
- 5. Bifurcated female gonad. — Iceland, "Thor" stat. 174(04). — $\times 5$.

Figures 6—10 *Tiaropsis multicirrata* (M. Sars).

- 6. Transverse section through radial canal with mature male gonads. — Hrafnarfjord, Iceland. — $\times 28$.
- 7. Transverse section through radial canal with immature female gonads. — Veidileysafjord, Iceland. — $\times 28$.
- 8. Transverse section through radial canal with mature female gonads. Most of the eggs have been detached, some eggs have not yet penetrated the ectodermal epithelium. — Dyrefjord, Iceland, August 4th 1896. — $\times 30$.
- 9. Lateral view of the proximal part of a radial canal with female gonads, showing a number of mature eggs situated on the outer side of the lateral wall of the canal. — From the same specimen. — $\times 15$.
- 10. The same radial canal seen from the ventral edge. — $\times 15$.

Figures 11—13 *Phialidium islandicum* nov. spec.

- 11. A specimen seen from the aboral side. — Iceland, "Thor" stat. 176(04). — $\times 2$.
- 12. Manubrium seen obliquely from the aboral side. — From another specimen from the same locality. — $\times 8$.
- 13. Section through the circular vessel and a marginal vesicle. — Iceland, "Thor" stat. 266(04). — $\times 220$.
- 14. *Phialidium hemisphaericum* (Gronovius). — Section through the circular vessel and a marginal vesicle. — Myri Bugt, Iceland, July 24th 1904. — $\times 220$.

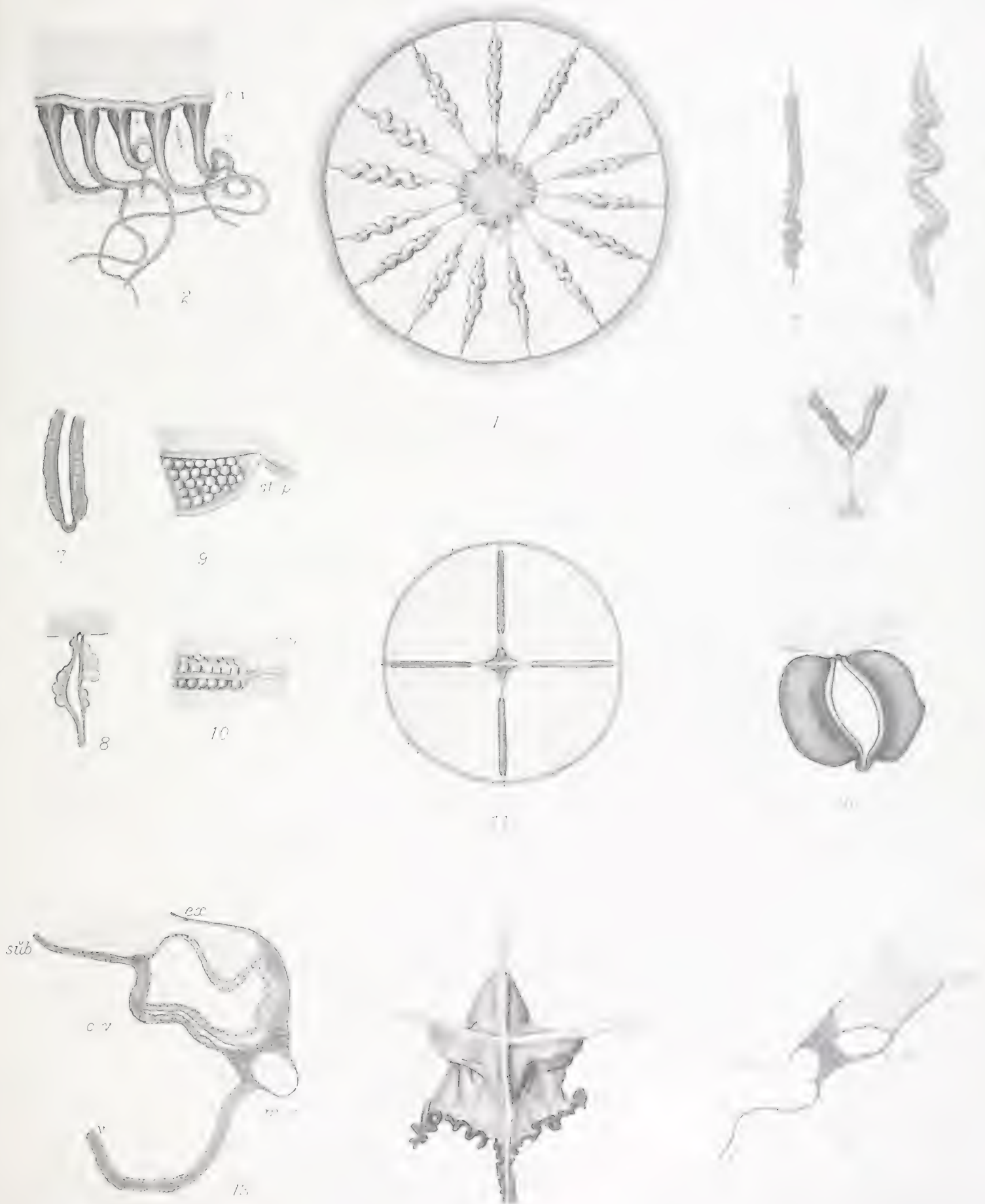


Plate V.

Plate V.

Figures 1—2. *Phialidium islandicum* nov. spec.

- Figure 1. Part of the bell-margin, showing marginal vesicles alternating with the tentacles. — Iceland, "Thor" stat. 176 (04). — $\times 20$.
- 2. Longitudinal section through a tentacular bulb, perpendicularly to the circular vessel. — Iceland, "Thor" stat. 266 (04). — $\times 50$.
- 3. *Phialidium hemisphaericum* (Gronovius). — Longitudinal section through a tentacular bulb, perpendicularly to the circular vessel. — Myri Bugt, Iceland. — $\times 50$.

Figures 4—10. *Tima bairdii* (Johnston).

- 4. Dorsal wall of the stomach, showing the four deep grooves and the entrances to the four radial canals; the two entrances to the left are closed, the two others are open, showing the transversal folds in the proximal part of the radial canals. The lateral walls of the stomach have been removed. — From a Danish specimen. — $\times 8$.
5. Lateral view of the manubrium and the lower end of the stomachal peduncle; showing the four large, folded lips and the triangular pouches between the dorsal wall of the stomach and the peduncle. The cross-shaped figure, along the arms of which the stomach is attached to the peduncle, is discerned through the jelly of the latter. In this specimen the "cross-arms" do not meet exactly in the centre. — From a Danish specimen. — $\times 8$.
6. Part of the bell-margin, seen from the abaxial side, with two tentacles (observe the abaxial spur-like projection at the base of the bulbs) and a number of marginal warts and marginal vesicles. — From a Danish specimen. — $\times 5$.
- 7. Lateral view of a tentacular bulb. The margin of the umbrella, the circular vessel, and the velum are seen in section. The basal spur on the tentacular bulb is distinctly visible. Above the tentacle is seen the rounded gelatinous protuberance of the exumbrella. — $\times 5$.
8. Section through the bell-margin and a tentacular bulb; showing the entodermal, basal spur, covered by the epithelium of the exumbrella. — $\times 12$.
9. Section through the bell-margin. The section has passed through the middle of a marginal wart with a marginal vesicle situated on the adaxial side close to the velum. — $\times 65$.
10. Transverse section through a radial canal (the part on the stomachal peduncle) with male gonads; showing the mode of attachment to the subumbrella, mentioned in the text, p. 103. — $\times 65$.



THE INGOLF-EXPEDITION

1895—1896.

THE LOCALITIES, DEPTHS, AND BOTTOMTEMPERATURES OF THE STATIONS

Station Nr	Lat. N	Long. W.	Depth in Danish fathoms	Bottom- temp.	Station Nr.	Lat. N	Long. W.	Depth in Danish fathoms	Bottom- temp.	Station Nr.	Lat. N	Long. W.	Depth in Danish fathoms	Bottom- temp.
1	62° 30'	8° 21'	132	7.2	24	63° 06'	56° 00'	1100	2.4	15	61° 22'	7° 34'	1000	2.5
2	63° 04'	9° 22'	202	5.3	25	63° 30'	54° 25'	382	3.5	46	61° 22'	11° 30'	1000	2.5
3	63° 35'	10° 24'	272	0.5		63° 51'	53° 03'	130		17	61° 22'	17° 40'	900	2.5
4	64° 07'	11° 12'	237	2.5	26	63° 57'	52° 41'	34	0.0	48	61° 22'	17° 11'	1150	2.5
5	64° 40'	12° 00'	155			64° 37'	51° 24'	100		49	62° 00'	18° 30'	1120	2.5
6	63° 43'	14° 34'	90	7.0	27	64° 51'	55° 10'	203	3.8	50	62° 47'	18° 50'	1020	2.5
7	63° 13'	15° 41'	600	4.5	28	65° 14'	55° 42'	420	3.5	51	64° 13'	14° 22'	90	2.2
8	63° 56'	24° 40'	130	6.0	29	65° 34'	54° 31'	68	0.2	52	63° 17'	13° 32'	40	1.1
9	64° 18'	27° 00'	205	5.8	30	66° 50'	54° 28'	22	1.03	53	63° 13'	13° 00'	30	2.0
10	64° 24'	28° 50'	788	3.5	31	66° 45'	55° 54'	88	1.0	54	63° 02'	15° 40'	60	1.5
11	64° 34'	31° 12'	1300	1.0	32	66° 35'	56° 38'	318	3.9	55	63° 30'	15° 32'	35	1.0
12	64° 38'	32° 37'	1040	0.3	33	67° 57'	55° 10'	33	0.8	56	64° 00'	15° 00'	68	1.0
13	64° 47'	34° 33'	622	3.0	34	65° 17'	54° 17'	35		57	63° 30'	14° 00'	300	1.3
14	64° 45'	35° 05'	176	4.4	35	65° 16'	53° 03'	302	3.0	58	64° 45'	14° 00'	300	2.0
15	66° 18'	25° 59'	330	0.75	36	61° 50'	50° 21'	1133	1.5	59	65° 00'	13° 00'	300	2.5
16	65° 43'	26° 58'	250	0.1	37	60° 17'	54° 03'	1715	1.4	60	65° 00'	12° 30'	300	2.0
17	62° 49'	20° 55'	745	3.4	38	59° 12'	51° 03'	1870	1.5	61	65° 00'	12° 00'	300	2.0
18	61° 44'	30° 29'	1135	3.0	39	62° 00'	22° 38'	863	2.9	62	65° 18'	10° 00'	300	2.0
19	60° 29'	34° 14'	1566	2.4	40	62° 00'	21° 36'	843	3.3	63	62° 00'	10° 00'	800	3.0
20	58° 20'	40° 48'	1695	1.5	41	61° 30'	17° 10'	1243	2.0	64	60° 00'	10° 00'	1041	2.0
21	58° 01'	44° 45'	1330	2.4	42	61° 41'	16° 17'	623	0.4	65	60° 00'	10° 00'	1080	1.5
22	58° 10'	48° 25'	1845	1.4	43	61° 42'	16° 11'	743	0.00	66	60° 00'	10° 00'	1128	1.5
23	60° 43'	56° 00'	Only the Plankton-Net used		44	61° 42'	9° 36'	38	0.3	67	60° 00'	10° 00'	975	1.5

Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom- temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom- temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom- temp.
68	62° 06'	22° 30'	843	3°4	92	64° 44'	32° 52'	976	1°4	118	68° 27'	8° 20'	1060	—1°0
69	62° 40'	22° 17'	589	3°9	93	64° 24'	35° 14'	767	1°46	119	67° 53'	10° 19'	1010	—1°0
70	63° 09'	22° 05'	134	7°0	94	64° 56'	36° 19'	204	4°1	120	67° 29'	11° 32'	885	—1°0
71	63° 46'	22° 03'	46			65° 31'	36° 45'	213		121	66° 59'	13° 11'	529	—0°7
72	63° 12'	23° 04'	197	6°7	95	65° 14'	30° 39'	752	2°1	122	66° 42'	14° 44'	115	1°8
73	62° 58'	23° 28'	486	5°5	96	65° 24'	29° 00'	735	1°2	123	66° 52'	15° 40'	145	2°0
74	62° 17'	24° 36'	695	4°2	97	65° 28'	27° 39'	450	5°5	124	67° 40'	15° 40'	495	—0°6
	61° 57'	25° 35'	761		98	65° 38'	26° 27'	138	5°9	125	68° 08'	16° 02'	729	0°8
	61° 28'	25° 06'	820		99	66° 13'	25° 53'	187	6°1	126	67° 19'	15° 52'	293	0°5
75	61° 28'	26° 25'	780	4°3	100	66° 23'	14° 02'	59	0°4	127	66° 33'	20° 05'	44	5°6
76	60° 50'	26° 50'	806	4°1	101	66° 23'	12° 05'	337	0°7	128	66° 50'	20° 02'	194	0°6
77	60° 10'	26° 59'	951	3°6	102	66° 23'	10° 26'	750	0°9	129	66° 35'	23° 47'	117	0°5
78	60° 37'	27° 52'	799	4°5	103	66° 23'	8° 52'	579	0°6	130	63° 00'	20° 40'	338	0°55
79	60° 52'	28° 58'	653	4°1	104	66° 23'	7° 25'	957	1°1	131	63° 00'	19° 09'	698	4°7
80	61° 02'	29° 32'	935	4°0	105	65° 34'	7° 31'	762	0°8	132	63° 00'	17° 04'	747	1°6
81	61° 41'	27° 00'	485	6°1	106	65° 34'	8° 54'	447	—0°6	133	63° 14'	11° 24'	230	2°2
82	61° 55'	27° 28'	824	4°1		65° 29'	8° 40'	466		134	62° 34'	10° 26'	299	4°1
83	62° 25'	28° 30'	912	3°5	107	65° 33'	10° 28'	492	—0°3	135	62° 48'	9° 48'	270	0°4
	62° 36'	29° 01'	472		108	65° 30'	12° 00'	97	1°1	136	63° 01'	9° 11'	256	4°8
	62° 36'	25° 30'	401		109	65° 29'	13° 25'	38	1°5	137	63° 14'	8° 31'	297	—0°6
84	62° 58'	25° 21'	933	4°8	110	66° 44'	11° 33'	781	0°8	138	63° 26'	7° 56'	471	0°6
85	63° 21'	25° 21'	170		111	67° 14'	8° 48'	860	0°6	139	63° 36'	7° 30'	702	0°6
86	63° 03'6	23° 47'6	76		112	67° 57'	6° 44'	1267	1°1	140	63° 29'	6° 57'	780	0°9
87	63° 02'3	23° 36'2	110		113	69° 31'	7° 06'	1309	1°0	141	63° 22'	6° 58'	679	0°6
88	64° 58'	24° 25'	76	6°9	114	70° 36'	7° 29'	773	1°0	142	63° 07'	7° 05'	587	—0°6
89	64° 45'	27° 20'	310	8°4	115	70° 50'	8° 29'	86	0°1	143	62° 58'	7° 09'	388	—0°4
90	64° 45'	29° 06'	568	4°4	116	70° 05'	8° 26'	371	—0°4	144	62° 49'	7° 12'	276	1°6
91	64° 44'	31° 00'	1236	3°1	117	69° 13'	8° 23'	1003	—1°0					

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